



Happiness and Environmental Quality

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A thesis submitted to the Department of Geography & Environment
of the London School of Economics for the degree of Doctor of Philosophy,
London, September 2011

Declaration

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Abstract

Subjective wellbeing — happiness — is of increasing interest to economists, including environmental economists. There are several reasons for thinking that environmental quality (EQ), defined as high levels of environmental goods and low levels of environmental ‘bads’, will be positively related to happiness.

Quantitative evidence on this remains limited, however. Some papers use cross-sectional data aggregated at country level, but it is open to doubt whether these aggregated measures reflect individuals’ real EQ exposures. Other papers use individual-level data, but in general have spatial data at very coarse resolution, and consider a limited range of EQ variables, exclusively around individuals’ homes.

This thesis reports two related strands of work. The first designs, implements and analyses data from two new cross-sectional surveys. It builds on earlier work by using spatial data at very high resolution, and advanced Geographical Information Systems (GIS) techniques; by simultaneously considering multiple EQ characteristics, around both homes and workplaces; and by investigating the sensitivity of results to the choice of happiness indicator.

The second strand develops and implements a new methodology focused on individuals’ momentary experiences of the environment. It extends a protocol known by psychologists as the Experience Sampling Method (ESM) to incorporate satellite (GPS) location data. Using an app for participants’ own smartphones, called *Mappiness*, it collects a panel data set comprising millions of geo-located responses from thousands of volunteers. EQ indicators are again joined to this data set using GIS.

Results of the first strand of work are mixed, but support some links between happiness and the accessibility of natural environments, providing quantitative (including monetary) estimates of their strength. The second strand demonstrates that individuals are significantly and substantially happier outdoors in natural environments than continuous urban ones. It introduces a valuable new line of evidence on this question, which has great potential for future development.

Acknowledgements

I would like to thank: Susana Mourato, Steve Gibbons, David Maddison, Francesca Cornaglia, Gordon MacKerron, Briony Goulden, Jouni Kuha, Raphael Calel, Antoine Dechezleprêtre, Rich Aston, Ellie Levenson and Johann Hari; all testers of the iPhone app; and all Mappiness study participants.

This work was supported by the UK Economic & Social Research Council (grant number PTA-031-2006-00280). Additional funding for the UK web survey was provided by the United Nations Environment Programme World Conservation Monitoring Centre (UNEP WCMC).

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List of Abbreviations

AONB	Area of Outstanding Natural Beauty
DRM	Day Reconstruction Method
EQ	environmental quality
ESS	European Social Survey
EMA	Ecological Momentary Assessment
ESM	Experience Sampling Method
GDP	Gross Domestic Product
GIS	Geographical Information Systems
GiGL	Greenspace Information for Greater London
GHQ	General Health Questionnaire
GLA	Greater London Authority
GPS	Global Positioning System
LAEI	London Atmospheric Emissions Inventory
LCM	Land Cover Map 2000
LHR	London Heathrow airport
LS	life satisfaction
LSOA	Lower Super Output Area
NEA	UK National Ecosystem Assessment
NO ₂	nitrogen dioxide
NNR	National Nature Reserve
OLS	Ordinary Least Squares
ONS	UK Office for National Statistics
OS	Ordnance Survey
OSM	OpenStreetMap
PANAS	Positive And Negative Affect Schedule
PM10	particles smaller than 10 microns diameter
PS	preference satisfaction
SF-36	Short-Form 36 (RAND-36) Health Survey
SO ₂	sulphur dioxide
SWB	subjective wellbeing

VIF variance inflation factor

WTA willingness-to-accept

WTP willingness-to-pay

Chapter 1

Introduction

1.1 Happiness, economics, and the environment

1.1.1 The economics of happiness

Economists are increasingly becoming interested in happiness, or subjective wellbeing (SWB)¹. In contrast to the standard economic account of wellbeing as the satisfaction of preferences, SWB research holds that wellbeing can be measured and compared between people; that this can be achieved simply by asking people how happy they are, and fitting econometric models to explain their responses; and that a wide range of influences on happiness are important and can be assessed empirically within such a framework.

The influences on happiness that this work highlights are comprehensively reviewed by Dolan et al. (2008). They include one's income (positively correlated with SWB); the incomes of others, because of rivalry (negative) and/or ambition (positive); and one's own past income, because of habituation (negative). They include unemployment; separation, divorce and widowhood; and poor health (all negatively correlated with SWB). They also include social capital indicators and 'relational goods', such as membership of interest groups or friendly relations with neighbours; trust; and belief in a god (all positively correlated with SWB).

They may also include environmental quality (EQ) characteristics such as climate, noise, air quality, and access to green spaces — which is the proposition that this thesis sets out to explore.

1.1.2 Happiness and the environment

Some environmental and ecological economists have taken a particularly strong interest in happiness economics. There are two main reasons for this. First, for those concerned with 'strong' sustainability especially, a significant advantage of happiness indicators and analyses is that they do not automatically conflate welfare and progress with consumption and growth (e.g. Gowdy, 2005).

Second, happiness economics offers a new means by which the effects of EQ characteristics can be quantified (Welsch, 2009; Ferreira & Moro, 2010) — either directly, in terms of their impacts on SWB, or in monetary terms, by estimating the change in income which would produce an SWB impact of equivalent size. As a method of monetary valuation this could represent a useful complement to conventional revealed- and stated-preference techniques, since it has quite different strengths and weaknesses in respect of its applications, assumptions and limitations (Welsch & Kühling, 2009).

1.1.3 Policy relevance

Both of these reasons for environmental and ecological economists' interest in happiness map quite directly to the policy realm. Although it in no way obviates debates over ethics, values or

¹In this thesis, as is usual in the literature, we use the terms SWB, wellbeing and happiness interchangeably. This decision is discussed in more detail in the next chapter.

objectives, a ‘new utilitarianism’ grounded in SWB research could inform policy development and evaluation at all levels (e.g. [Diener et al., 2009](#)).

On the international scale the last several years have seen initiatives launched by the EU (*Beyond GDP*), the OECD (*Measuring the Progress of Societies*), and individual nation states including the UK, France and Canada. All have proposed wider use of SWB measures as part of a reconceptualising of policymakers’ notions of prosperity and progress — a shift that policy organisations with interests in sustainability have been promoting for some time (e.g. [Jackson, 2009](#); [Michaelson et al., 2009](#)).

On a smaller scale, the methods of happiness economics may be used to evaluate the social costs and benefits of specific projects or policies — including environmental projects and policies — in the first instance by translating effects on SWB into monetary values. To date, SWB valuation methods have almost universally produced values that seem implausibly high (e.g. [Ferreira & Moro, 2010](#)); but research is ongoing, and HM Treasury has this year updated its *Green Book* — the appraisal and evaluation framework for UK central government — to incorporate discussion on this topic for the first time ([HM Treasury, 2003](#), p. 58)².

Day to day, meanwhile, the findings of happiness economics might also be used directly by individuals to improve their own wellbeing, since they highlight areas in which bounded rationality — including systematic mis-prediction of future utility — leads to widespread but avoidable patterns of sub-optimal choice (e.g. [Stutzer & Frey, 2008](#)).

1.1.4 Existing research

Economic evidence on the relationship between EQ and happiness exists, but it is less strong than for many other factors (such as income, employment, or marital status). Published studies report positive impacts, but they have some common weaknesses.

Country-level studies have predicted national average SWB levels using nationally aggregated indicators of EQ (e.g. [Welsch, 2002](#)). For characteristics such as air pollution that vary at a sub-national scale, however, these aggregated variables are not convincingly related to individuals’ real exposures to EQ. Furthermore, these studies do not always adequately control for the many other sources of heterogeneity between nations.

Individual-level studies have modelled individuals’ SWB reports using EQ indicators for the vicinity of their homes. However, these studies have still generally relied on large-area aggregates of EQ measures; have focused exclusively on the levels or existence of EQ characteristics, rather than real-life exposures or use; have looked for the most part at isolated EQ variables, despite widespread correlations (such as between air pollution and noise); and have not, to date, investigated links with land cover — the effects of green spaces and ‘blue spaces’, such as rivers, lakes and sea.

Some of the best and most direct evidence regarding other influences on wellbeing, such as health status or companionship, comes from experience-level studies using the Day Reconstruction Method, Experience Sampling Method, or Ecological Momentary Assessment (DRM, ESM, EMA). These methods minimise biases of recall and interpretation, and provide rich panel data sets in which time-invariant individual characteristics, including personality, can be factored out ([Csíkszentmihályi & Hunter, 2003](#); [Krueger & Schkade, 2008](#)). To our knowledge, however, these methods have never been applied to hypotheses regarding EQ.

1.2 Aims and methods

The research described in this thesis starts from the hypothesis that positive EQ characteristics — air quality, tranquillity, and green and blue space — will be positively related to SWB.

We conduct two separate but related strands of empirical research. Both involve substantial new primary data collection. Both aim to test the hypothesis that EQ characteristics are significantly related to individuals’ SWB, and to measure the extent of these relationships, in some cases in monetary terms. In relation to previous research, the first strand makes incremental progress in several areas, while the second takes a more radically new direction.

Both strands of work offer significant advances on earlier research in this field.

²This edition of the Green Book is officially still dated 2003, but pages 57 – 58 were updated in 2011.

1.2.1 Retrospective happiness and the usual environment

In the first strand we build directly on previous work in happiness economics that links retrospective happiness assessments to respondents' usual environments, extending and improving on this in a number of areas.

1.2.1.1 Summary of methods

We design, implement, and collect and analyse data from two new cross-sectional web surveys. We use Geographical Information Systems (GIS) software to link survey respondents' home and workplace locations to objective indicators of EQ, and estimate econometric models that use these indicators to predict SWB responses. Using the results of these models, we calculate monetary values for EQ characteristics where applicable.

As EQ variables we consider road, rail and aircraft noise, air pollution, and land cover (including green and blue space types), while controlling for house prices and for proxies of other spatial amenities and characteristics.

1.2.1.2 Study areas

The first survey is completed by a quota sample of approximately 1,000 Londoners, and the second by a quota sample of approximately 2,000 people across the UK. Working at these two scales brings different advantages and limitations, enabling different EQ characteristics to be investigated effectively.

London For London, a range of high-resolution spatial data sets exist that are not available UK-wide, such as modelled air pollutant concentrations and noise levels from roads and railways. London also has distinctive EQ characteristics. Its air quality is the worst in the UK and among the worst in Europe, consistently exceeding EU limits for nitrogen dioxide and particulates³ ([Greater London Authority, 2005](#)), and most residents see this as a significant environmental problem ([Ipsos MORI, 2007](#)). It is also one of the larger cities in the developed world, and most residents are thus some distance from any wild natural environment. On the other hand, it has more parks and green spaces than any other city of comparable size worldwide ([Office for National Statistics, 2007a](#)).

UK The UK as a whole is of course much more heterogeneous than London in terms of EQ characteristics. The UK-wide survey provides greater variation in land cover types, and permits meaningful distinctions in relation to distance variables which in London cannot be separated from other geographical characteristics⁴.

1.2.1.3 Original contribution

This work makes a significant contribution to the literature by building on previous research in the following ways:

High resolution spatial data Most existing studies have access to EQ data and respondent location only at ward level (or worse). By contrast, most of the EQ data we use is of 25m resolution or better. We have full UK postcodes for all respondents, and in London we ask respondents to locate their home even more precisely using an interactive map survey item, which we develop for this purpose. This additional precision in location is particularly valuable in relation to air pollution and noise estimates, since these indicators may vary over very short distances⁵.

³Particulates on the Underground system represent an additional and distinctive source of airborne pollution in London, although these are not believed to be significantly harmful ([Seaton et al., 2005](#)).

⁴For example, distance to the coast in London is approximately just a measure of westerliness.

⁵[MacKerron & Mourato \(2009\)](#) use the same high resolution air pollution maps, but have only postcode location data from a small convenience sample.

Advanced GIS methods For measures that are not point estimates — such as the accessibility of particular land cover types — we make use of advances in GIS that have been exploited in hedonic pricing studies, but have not previously been applied in happiness economics research. We measure the local quantity of amenities by calculating the proportion of land they represent within a certain radius of respondents' locations. We also calculate more advanced measures accounting for both quantity *and* proximity, in the form of kernel-weighted proportion estimates.

Multiple EQ characteristics Unlike some previous studies of SWB and EQ, which focus on a single element of EQ, we combine a range of EQ characteristics in a single model. We intend this to somewhat ameliorate problems of omitted variable bias in the case of interrelated characteristics, such as air pollution, noise and green space.

Green and blue space We consider a number of EQ characteristics which have not previously been included in happiness economics research, including accessibility of green and blue space.

Looking beyond the home To try to achieve a more complete picture of EQ exposure, we estimate SWB models including EQ characteristics not only at respondents' residential locations, but also at their workplaces.

Sensitivity to SWB indicator We compare the results of using several alternative SWB indicators. This kind of sensitivity testing has rarely been done in happiness economics research, and as far as we are aware has never been done in work on EQ.

Valuation best practices We follow a number of the recommendations for high-quality SWB valuation research emerging from the most recent valuation literature, including [Fujiwara & Campbell \(2011\)](#).

1.2.2 Momentary happiness and the immediate environment

In the second strand of research we design, implement, and collect and analyse panel data from a unique and large-scale ESM study. We enhance the standard ESM protocol to include precise geographical coordinates, enabling us to link objective indicators of spatial characteristics to every response received. We believe that this is the first ESM study to address — or be capable of addressing — hypotheses regarding EQ.

In addition, we achieve what we believe to be the largest ESM sample ever collected: more than one million responses from over 20,000 participants. We do so by making use of individuals' own smartphones as response devices, by prioritising speed and ease of use in our signalling and response protocols, and by offering interesting feedback to participants in relation to the data they provide.

1.2.2.1 Summary of methods

We develop a native software application (app), named *Mappiness*, that runs on the Apple iPhone. We distribute the app via the iPhone App Store, a central software repository accessible to all device users. Participants are recruited opportunistically, assisted by coverage in traditional and social media.

Prospective participants download the app at no charge, indicate their informed consent to take part, and provide some basic demographic information. They are then signalled at random moments and asked to report on their mood on a continuous sliding scale. They are also asked whom they are with, where they are, and what they are doing. While they answer, their precise location is determined by satellite positioning (GPS). All data are then transmitted wirelessly to our data server. Participants receive simple feedback, charting their happiness in different contexts, and can take part for as long or short a period as they wish.

To each response received from participants we join indicators of land cover at the response location, and daylight and weather conditions at the appropriate location and time, using GIS. We then estimate fixed effects models predicting happiness responses from the objective spatial data, while controlling for activity, companionship, location type, time, day, and any response trend.

1.2.2.2 Study area

While this study could easily be extended worldwide, each additional country included would require a new collection of environmental data sets to be identified, obtained and processed. At present, we therefore limit our analyses to the UK.

1.2.2.3 Original contribution

Since commencing this research we have become aware of other studies using smartphones to collect data from large samples — a method sometimes referred to as (or as a part of) crowdsourcing, ubiquitous computing (UbiComp), or citizen (cyber-)science⁶. However, we know of only one such study that investigates wellbeing — [Killingsworth & Gilbert \(2010\)](#) — and that study is not able to investigate environmental factors since location data is not collected.

We therefore believe that our spatial experience sampling methodology is novel both within happiness economics and more broadly. It provides an entirely new line of evidence on the links between wellbeing and EQ, which may ultimately be of significant use to environmental policymakers⁷.

It is also a powerful line of evidence compared to that provided by cross-sectional approaches. Because we ask the same people the same subjective questions many times, we need not assume comparability of different individuals' use of the response scales, and all individual characteristics that are invariant over the study period can be controlled through the use of fixed effects. Because we observe each individual in multiple locations, we break potential associations between people and locations that may confound cross-sectional research. Because we can precisely and objectively locate individuals at the moment of each response, the EQ indicators that we calculate should much more closely reflect actual exposures to EQ. And because we collect an extremely large sample, we may have the statistical power to detect even small EQ effects.

Additionally, since we use many of the same EQ indicators in both strands of our research, we hope for the first time to compare relationships between retrospective happiness and usual environment, and between momentary happiness and immediate environment, contributing further to existing understanding of the relation between SWB and EQ.

1.3 Structure of thesis

The remainder of this thesis is set out as follows. In [chapter 2](#) we review the happiness economics literature, structuring our discussion around the following seven questions. What is happiness economics? What does it involve? Is it real economics? Who does it? What does it tell us? And what does it mean for policy?

In [chapter 3](#) we narrow our focus to environmental factors, and briefly address two further questions. For what reasons might we expect links between EQ and happiness? And what evidence is there that such links exist?

The next five chapters address our empirical contributions on that latter question. For the first research strand, looking at retrospective happiness, data collection methods are described in [chapter 4](#), methods of spatial and econometric analysis are outlined in [chapter 6](#), and results are presented and discussed in [chapter 7](#).

For the second strand, investigating momentary happiness, our spatial experience sampling methods are described in [chapter 5](#), methods of analysis are again outlined in [chapter 6](#), and results and discussion are presented in [chapter 8](#).

[Chapter 9](#) concludes with a brief synthesis of our findings, suggestions for future work in this area, and some wider implications of this research.

⁶Studies and enabling technologies are described, for example, at <http://trackyourhappiness.org/> (Killingsworth & Gilbert, 2010), <http://www.ccs.neu.edu/home/amislove/twittermood/>, <http://web.mit.edu/wockets/>, <http://myexperience.sourceforge.net/>, and <http://www.projectcharm.info/>.

⁷The value of this method is not confined to environmental questions, however: it has applications in many other areas of academic and market research, including transport, tourism, and consumer behaviour.

Chapter 2

Happiness economics

An earlier draft of this chapter is published in the Journal of Economic Surveys (MacKerron, 2011a).

We begin by asking: what is “happiness economics”? At first glance, happiness might seem an unlikely subject of study for a dismal science in which, traditionally, “every mind is inscrutable to every other mind, and no common denominator of feeling seems possible” (Jevons, in Black, 1990, p. 9). It could also seem a slightly presumptuous one: does it suggest an attempt by economists to colonise not just neighbouring disciplines (e.g. George, 2007), but the whole search for meaning in life? It might even come across as somewhat sinister — a cold, rational calculus of human emotion could recall dystopian visions such as those of Orwell’s *1984* or Huxley’s *Brave New World*. But it is potentially an intriguing subject too: it almost appears to hold out the impossible prospect of an analytical solution to the world’s ills. And, for economists, it offers a new (or rediscovered) intellectual territory where the returns to exploration remain relatively high.

This combination of characteristics has assured happiness economics sustained media coverage, certainly out of proportion to the volume of economic research it represents¹. But that volume is increasing rapidly: Figure 2.1 on the following page, which plots by year the number of journal article results for a simple EconLit search, gives some indication of its extraordinary growth. And the topic has more recently begun to receive attention — if not always approval — in some of the more prestigious economic journals².

There are many applied papers that report empirical associations between happiness and other variables. There are rather fewer that treat happiness economics in relation to its origins, definitions, theory, methods, applications, critiques, relations with other areas of economic research, political and policy connections, and promising areas for future research. This chapter aims to provide a broad overview of the happiness economics literature to date in relation to all of these.

Section 2.1 explores what ‘happiness’ has meant and can mean in economics, principally through the contrast between utility theory and subjective approaches. Section 2.2 considers how this research proceeds, while section 2.3 asks if it really constitutes economics. Section 2.4 asks in what specific areas of the discipline the resurgence of subjective approaches has taken place, and section 2.5 outlines the main findings. The implications of these findings for public policy are discussed briefly in section 2.6. Section 2.7 suggests some future directions for happiness research in economics, and section 2.8 briefly summarises and concludes.

¹The UK media regularly reports on happiness research. For example: a BBC TV series, *Making Slough Happy*, aired in Autumn 2005 (BBC News, 2005), and another, *The Happiness Formula*, was shown in Spring 2006 (Rudin, 2006). Happiness was front page news in the Economist’s (2006) Christmas edition — ‘Economics discovers its feelings: not quite as dismal as it was’ — and an Independent on Sunday supplement early in January 2007 was devoted to it (Leith, 2007). It has also found a place in popular non-fiction (e.g. Layard, 2005a; Gilbert, 2006; Haidt, 2007). All this is in spite of the fact that, to those not familiar with the preference satisfaction economic orthodoxy, economists’ recent findings regarding SWB can sometimes seem underwhelming: “money can’t buy happiness” is arguably a cultural commonplace, and related ground was covered over 40 years ago, for example, in Robert Kennedy’s celebrated (1968) speech listing all those things not accounted for by the Gross National Product (GNP).

²For example, the Journal of Economic Literature, the Journal of Economic Perspectives and the Journal of Political Economy — three of the top five economics journals by impact factor in the 2008 ISI Web of Knowledge Journal Citation Reports — have all published papers on happiness in the recent past (e.g. Frey & Stutzer, 2002b; Di Tella & MacCulloch, 2006; Rayo & Becker, 2007a).

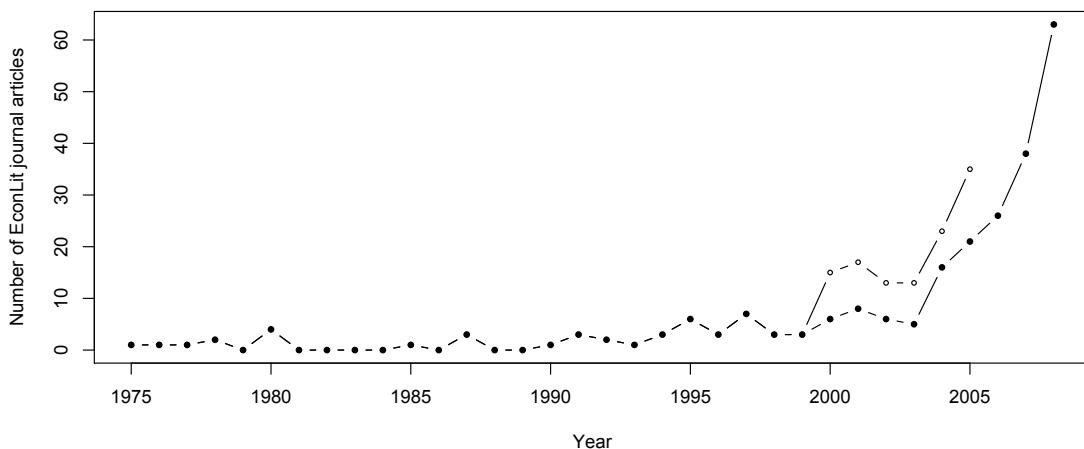


Figure 2.1: Number of EconLit journal articles with titles including the terms 'happiness', 'wellbeing', 'well-being' or 'life satisfaction', by year. The series plotted with filled circles excludes articles from the Journal of Happiness Studies.

2.1 What does happiness mean in economics?

In this thesis, the terms 'happiness' and 'wellbeing' are used interchangeably (the weaknesses of this approach are considered in subsubsection 2.2.1.1, but it is widespread — see, for example, Ferrer-i-Carbonell, 2005; Ormerod & Johns, 2007; Rehdanz & Maddison, 2005; Easterlin, 2006). Absent any disciplinary affiliation, there is a range of ideas that we might want to convey by such words. A useful typology, distinguishing five broad accounts of wellbeing, is offered by Dolan et al. (2006). Their five accounts are: (1) *preference satisfaction*, in which wellbeing consists in the freedom and resources to meet one's own wants and desires; (2) *objective lists* (or *basic needs*), in which wellbeing is the fulfilment of a fixed set of material, psychological and social needs, which are identified exogenously; (3) *flourishing* (or *eudaimonic*), in which well-being means the realisation of one's potential, along dimensions such as autonomy, personal growth, or positive relatedness (e.g. Ryff & Keyes, 1995); (4) *hedonic* (or *affective*), in which wellbeing is synonymous with positive affect balance, a relative predominance of positive moods and feelings; and (5) *evaluative* (or *cognitive*), in which wellbeing is the individual's own assessment of his or her life according to some positive criterion.

2.1.1 Preference satisfaction and subjective wellbeing

Orthodox, neo-classical economics relies overwhelmingly on the preference satisfaction (PS) account of wellbeing. The new (and perhaps still somewhat heterodox) happiness economics concerns itself predominantly with the evaluative account, and to some extent with the hedonic account, generally lumping these two together under the banner of 'subjective wellbeing' (SWB). These two principal approaches to happiness in contemporary economics — PS and SWB — do share some core premises. In particular, they both generally reject external criteria or judgements, privileging the individual as the only one qualified to assess his or her own wellbeing (this allowing both of them potential compatibility with both egalitarian and libertarian political views).

There is much that differentiates them, however. In fact, it is possible to sketch the development over time of each approach as motivated by perceived shortcomings of the other. Several authors point to 'paradoxes' and 'revolutions' in this process (e.g. Frey, 2008a; MacCulloch & Di Tella, 2005; Gowdy, 2004).

First, the neo-classical (PS) project is born at least partly out of dissatisfaction with the strongly hedonic flavour of late nineteenth-century economics. The cardinalist and utilitarian ideas of those such as Bentham, Mill, and later Edgeworth³ are challenged by others, including Jevons,

³Edgeworth went so far as to imagine the 'hedonometer', "an ideally perfect instrument, a psychophysical machine,

Pareto, and later Robbins, for whom inter-personal comparisons of happiness are impossible, and for whom neither psychology nor ethics belong within a positivist economic science (Sen, 2008; Bruni & Sugden, 2007)⁴.

Later, deficiencies of the PS account and its associated methods spur a ‘counter-revolution’: the rediscovery within economics of SWB accounts, by Richard Easterlin (whose 1974 paper is often cited as a beginning of this process), the ‘Leyden school’ (see subsection 2.4.4), and others. Differing judgements as to the meaningfulness and inter-personal comparability of subjective self-ratings of wellbeing are thus at the heart of the distinction between the PS and SWB approaches. Out of these, each approach has developed its own set of methods, theories and assumptions.

2.1.1.1 Preference satisfaction

In its strictest form the PS approach, since it steers clear of subjective data and rules out interpersonal comparisons, is left with a limited number of interesting things to say directly regarding happiness, or its closest available synonym, utility. Utility is to be understood only an index, an analytically instrumental quantity, which individuals need not be assumed to experience or understand. Assuming only that individuals’ preferences conform to the axioms of completeness, transitivity, reflexivity and continuity, and that they always choose their most preferred option, then individuals will behave *as if* they are maximising utility, and their behaviour can be modelled and analysed as such⁵. The set of choices an individual can make is understood to be constrained by his or her budget and, assuming non-satiation, a larger budget always implies that more highly preferred options can be chosen. It then follows that utility will be increasing in income: for utility u and income y , $u = U(y)$, $U' > 0$ and (optionally) $U'' < 0$.

2.1.1.2 Subjective wellbeing

The empirical SWB literature often leaves its theoretical base largely unstated. The premises are also straightforward, though. The fundamental distinction from PS is the conviction that there is a quantity, ‘happiness’, that individuals experience and that can be modelled *and measured* directly⁶. SWB research thus throws any and every potential influence on happiness into a function together, wraps this in a reporting function, and proceeds to estimate coefficients empirically.

Implicitly, then, there is a mental quantity representing experienced happiness, h , which is explicable by a vector of characteristics x , and can be evaluated and reported as a quantity r : $h = H(x)$, $r = R(h)$. To be a useful insight into h , the form of the reporting function $R(\cdot)$ must satisfy $R' > 0$ or at least $R' \geq 0$. Usually, both $H(\cdot)$ and $R(\cdot)$ must be the same across individuals (Senik, 2005). $R(\cdot)$ must also be assumed independent of x except as mediated by $H(\cdot)$.

Various further assumptions are necessary according to the method of analysis. $R(\cdot)$ is generally bounded between a lower and upper limit and, depending on our precise SWB concept, may in fact represent a series of psychological processes including recollection and aggregation of experiences through time; it is generally assumed that $R(H(x))$ can be modelled as a linear or log-linear function of x ; analysis of panel data assumes stability of $H(\cdot)$ and $R(\cdot)$ over time; use of

continually registering the height of pleasure experienced by an individual...”, whose readings one might “integrate through all time and over all sentience” (1881, in Colander, 2007).

⁴The hedonic and utilitarian economics of the late nineteenth century can in itself be understood partly as a reaction to the classical political economy of those such as Smith, Ricardo and Malthus. Their work is not expressed in the language of (or equipped with the methods now associated with) PS. But it is nonetheless concerned primarily with income, wealth and material needs — understandably, at a time when these were more pressing problems for more people than they are today in what is now the developed world (Pasinetti, 2006).

⁵In respect of the axioms of consumer preference: *completeness* means that for any two options or ‘bundles’, an individual must prefer one or the other, or be indifferent; *transitivity* means that — for options A, B and C — if the individual prefers A to B and B to C, he or she must also prefer A to C; and *reflexivity* means that if A and B are the same, then the individual must be indifferent between them. These three axioms define economic rationality. To produce defined and ‘well-behaved’ utility functions, we may also assume: *continuity*, such that if A is preferred to B then things that are sufficiently close to A will also be preferred to B; *non-satiation*, such that having more of A is always preferred, however slightly, to having less; and *strict convexity*, such that some balance of items X and Y is preferred to an extreme quantity of either. A fuller treatment of consumer preference and utility theory can be found in any microeconomics textbook.

⁶We note that utility is in fact modelled directly in various other areas of economics, such as in the application of random utility models (and that our summary of the PS approach could therefore be argued to be something of a straw man). The PS approach does not extend to direct utility measurement, however.

OLS, or of r values averaged across individuals, assumes cardinality; and so on. The assumptions required by different methods of analysis are discussed further in subsection 2.2.2.

The vector \mathbf{x} can be include just about anything, but economists have been especially interested in relative income variables (both time-lagged and peer incomes: $y_{i,t} - y_{i,t-1}$, $y_i - \bar{y}$) and macroeconomic variables, including unemployment, inflation, and governance. Most of the happiness research published in mainstream economics journals to date has concerned itself with these explanatory factors, but there is perhaps increasing interest in other influences, such as indicators of social and environmental capital.

There is no easy mapping between the PS concept of utility and SWB measures of happiness. Neither is defined explicitly; each is a black box, only truly comprehensible to the individual concerned — if even to them — and then perhaps only tacitly. Utility is whatever individuals (prospectively) behave as if to maximise; SWB is whatever individuals understand by the question they are asked, used (generally retrospectively) as a guide to recollecting, filtering, aggregating and reporting their experience.

Intuitively, some understanding of happiness probably is what most people are trying to maximise, and SWB measures are sometimes described as measures of 'experienced' utility, in contrast to the expected or 'decision' utility yielded by the PS approach (Kahneman et al., 1997; Kahneman & Sugden, 2005). But while this does capture a useful distinction between the two quantities, it would be misleading to portray them, as this terminology might imply, as simply prospective and retrospective versions of an equivalent metric⁷. Van Praag (1991) and Clark et al. (2008b) discuss the relationship in greater depth.

2.2 What do happiness economists do?

Having considered broadly what is meant by happiness economics, this section asks: how does research in happiness economics proceed?

2.2.1 Measuring happiness

SWB data consist, more or less by definition, of the aggregated self-reports of individuals — what people say about themselves when asked⁸. Widely used data sets with wellbeing items include those from the World Values Survey, European Social Survey, German Socio-Economic Panel and British Household Panel Survey.

As noted at the end of subsection 2.1.1, what exactly people report must depend on the questions that are asked of them and on the interpretations they give these. This simple observation raises a number of issues.

2.2.1.1 Concepts and terminology

This chapter has up to this point contrasted SWB with other accounts of or approaches to wellbeing and happiness. But SWB is not a monolithic concept; it is itself an umbrella term for a number of distinct ways of conceiving of a person's wellbeing. Many different survey questions have been taken as measuring SWB in the literature to date: the World Database of Happiness catalogues over a thousand (Veenhoven, nd). These questions differ in a number of respects, including the breadth and timescale of experience encompassed, and the words in which the idea of wellbeing is expressed (which have included, for example: happiness; satisfaction with one's

⁷Although compare Rayo & Becker (2007b, p. 487): "we consider that maximising happiness is closely linked, if not identical, to maximising utility in the standard economic way".

⁸Studies of happiness have also used data based on reports by others (the subjects' friends or colleagues, or mental health professionals, for example) and on subjects' observed behaviour (such as smiling, or even suicide attempts). Whether these measures constitute *subjective* wellbeing data is debatable. On the one hand, they are certainly not objective data as understood within a strict objective list or preference satisfaction approach — for example, data on suicide attempts would not be relevant under these approaches to wellbeing, since suicide may be attempted by people who are objectively well provided for, and well able to satisfy their consumption preferences. On the other, they are clearly not subjective in the sense of data arising more or less directly from subjects' experiences and perceptions of their own mental states — even if they may still be powerful indicators of those experiences and perceptions.

life situation, with life as a whole, or with quality of life; enjoyment of life; contentment; and many other variants).

Authors generally seem to have reflected rather little on the wide range of terms employed in research under the SWB banner, and to have shown a perhaps surprising lack of unease about this⁹. Empirically, studies asking different questions have produced results that are generally fairly consistent with each other. But the use of different questions does make comparison of findings between studies problematic: it is difficult to be sure that any differences are not simply the result of nuances in the terms (and therefore concepts) in the questions.

Communication and policy considerations may be one reason for the use of different terms, and the terminology used in reporting research may not match that used in the research itself. For example, a New Economics Foundation policy workshop identified “confusion/conflation with happiness” as a threat to the use of wellbeing in policy (Thompson & Marks, 2008, p. 24) even though in the report of this same workshop those terms are used interchangeably and without clarification. On the other hand, ‘happiness’ seems to be used more widely than ‘wellbeing’ in media reporting of SWB research¹⁰. Hence a study that actually asked respondents about ‘life satisfaction’ may be reported in the media as dealing with ‘happiness’ and to policy-makers as a ‘wellbeing’ study.

It seems possible, too, that economists have not wished to dwell on the variety of related but distinct wellbeing ideas because to do so would cast doubt on the potential for any one of them to represent a proxy for decision utility — the thing that individuals seek to maximise — and hence on the validity of their use for monetary valuation (see subsection 2.2.3).

As noted in section 2.1, certain terms are used interchangeably in this thesis too — since essentially all the literature does so, it now appears impractical to do otherwise.

2.2.1.2 Domains and timescales

SWB can be measured using either single- or multiple-item scales. Multiple-item scales pose the question whether and how to aggregate the individual items. Some multiple-item scales focus purely on the evaluative aspects of SWB, asking about satisfaction in different life domains (work, relationships, finances, and so on — e.g. Cummins et al., 2003). Others take a wider view, with items covering evaluative, hedonic and eudaimonic aspects (e.g. Huppert et al., 2009). Still others, such as the General Health Questionnaire (GHQ), focus more on symptoms of unhappiness or psychological distress (e.g. Clark & Oswald, 1994).

So far, research within economics has tended overwhelmingly to focus on single-item measures. On a pragmatic level, single-item measures have good data availability: they are included in several major surveys. Analysing a unitary quantity of something utility-like is familiar economic territory, and makes monetary valuation straightforward. And use of a single-item scale may be justified by the contention that the individual concerned is best placed to aggregate all the different aspects of his or her own wellbeing. On the other hand, single-item measures have poorer reliability (Huppert et al., 2009) and, outside the discipline at least, not everyone is happy with an opaque and individualised aggregation function (for example, Michalos — 2008, p. 360 — writes that “moving Pandora’s Box of aggregation problems from the visible world to the invisible Black Box inside people’s heads does not strike me as a progressive research programme”).

SWB can also be measured over various timescales. In the data most commonly used by economists, respondents are asked about the vague present (“these days”, “nowadays”, “the last few weeks”, and so on)¹¹. These data are termed “retrospective assessments” by Kahneman &

⁹Even some who have noted the inconsistency of terminology in a context rather critical of SWB have not flagged it as a potential issue (e.g. Johns & Ormerod, 2007, p. 22). Other examples include: Clark et al. (2005), who note the variety of “well-being variables” — “some are global indices, such as happiness, life satisfaction or psychological stress, others are domain specific, such as job or income satisfaction” (p. C118) — but do not discuss whether they measure the same quantity, and go on to describe the ‘satisfaction with financial situation’ indicator they use as a ‘reported well-being’ or ‘utility’ variable, despite noting (without further explanation) that they “would have preferred a general life satisfaction measure here” (P. C120); and Di Tella & MacCulloch (2006) who, despite providing a very thoughtful commentary on other aspects of the reporting of ‘happiness’ scores, talk about happiness data (e.g. US General Social Survey, p. 27) and life satisfaction data (e.g. German Socio-Economic Panel, p. 30) interchangeably and without comment.

¹⁰For example, a Nexis UK search of UK national newspaper headlines between 24 January 2007 and 24 January 2012 gives 1,393 matches for ‘happiness’ and 790 matches for ‘wellbeing’.

¹¹For example: the German Socio-Economic Panel (GSOEP), which asks about life satisfaction “at present” (e.g. Luechinger, 2009; Ferrer-i-Carbonell, 2005); the European Social Survey, which asks about life satisfaction “nowadays”

Krueger (2006) — and elsewhere in this thesis — although in some cases future expectations could arguably be relevant too. In either case, there is often a lack of clarity as to what exactly is to be assessed on the time dimension. Even where the timescale of the assessment is more precise¹², the recollection and aggregation of experiences has been shown to be systematically distorted — such as by neglect of experiences' duration (Kahneman & Thaler, 2006) — relative to a simple average of momentary utilities (Robinson & Clore, 2002).

On the other hand, in respect of this benchmark, it could also be argued that a recollected and aggregated assessment is as valid a measure of SWB as a perfect integral of momentary experiences over time: humans do not live exclusively in the immediate present. The key point is simply that these are different sorts of quantities: Kahneman & Deaton (2010, p. 16492), for example, stress “the distinction between the judgments individuals make when they think about their life and the feelings that they experience as they live it”.

Experience sampling or reconstruction As implied by the above discussion, SWB measures have been devised to approximate the average or integral of individuals' momentary utilities too (Kahneman, 1999, p. 5). With a flavour of Edgeworth's 'hedonometer', these come from either Experience Sampling Method (ESM) or Day Reconstruction Method (DRM) studies.

In ESM studies, participants are signalled a number of times over a given period — say, eight times a day, for seven days — and are asked about aspects of their mental state, where they are, what they are doing, and who they are with (Hektner et al., 2007). In the medical literature, the term Ecological Momentary Assessment (EMA) describes a broad family of similar methodologies (Smyth & Stone, 2003; Shiffman et al., 2008). The logistics of supplying and requiring participants to carry handheld computers or pre-printed response forms have until recently limited the scale of ESM studies, but technological developments are beginning to obviate this issue (e.g. Collins et al., 2003; Goodwin et al., 2008), and one ESM study has already made use of respondents' own smartphones (Killingsworth & Gilbert, 2010).

DRM studies aim to collect similar information to ESM, but to do so less intrusively. These studies simply ask participants to break the previous day into episodes and to report the context of, and their feelings during, each episode. DRM data may be subject to greater recall bias than ESM data — which is regarded as the “gold standard” here — but it also offers richer information on time use, given a fixed period of data collection, since it deals in periods rather than moments (Kahneman et al., 2004b).

Finally, if it is judged most important to increase the wellbeing of those who have less of it (potentially for good philosophical and political reasons), this moment-in-time data is sometimes reduced to a measure of the proportion of time respondents report spending below some predefined threshold. This measure has been dubbed the U-Index (Kahneman & Krueger, 2006).

2.2.1.3 Interpretation and response

Regardless of the terminology used and the timescale asked about, what a respondent reports will depend on his or her own understanding of the question. Random variation between different individuals' interpretations — as long as they are not wholly dissimilar — may simply be regarded as a source of measurement error. The extent of this error may depend partly on the choice of terms, since some appear more capable of multiple interpretations than others (the word 'happy' seems especially problematic, capable of expressing anything from momentary "smiley-face feelings" to self-realisation, flourishing and achievement — Annas, 2004). Multi-item scales, using a variety of terms, may help to reduce it.

Culture and language Non-random variation in interpretations represents a more serious challenge to the validity of SWB research. An obvious source of such variation is individuals' cultural and linguistic backgrounds. And there are identifiable cultural groupings in SWB ratings: historically-communist countries may tend to lower scores; historically-Protestant, island and south-American nations to higher ones (Inglehart & Klingemann, 2003; Marks et al., 2006a).

(e.g. Layard et al., 2008); the World Values Survey, which asks about life satisfaction “these days” (e.g. Bruni & Stanca, 2008); or the US General Social Survey, which asks about happiness “these days” (e.g. Easterlin, 2003).

¹²For example, some of the items devised by Huppert et al. (2009) ask specifically about the past week.

Given ratings' subjectivity, it is arguably impossible to determine how far cultural differences in ratings reflect varying levels of actual, experienced SWB. However, different interpretation and reporting styles seem likely to be at least part of the story. While there may be some simple, universal concepts, 'happy', 'satisfied' and 'wellbeing' are probably not among them; for example, 'happy' appears weaker in meaning than straightforward translations in some other European languages — including the French 'heureux', Italian 'felice' and Russian 'sčastlivyj' (Wierzbicka, 2004). In some cultures it may also be important to distinguish public values from private values (Littlewood, 2008, p. 3)¹³. More generally, the potential for social desirability biases needs to be acknowledged and, ideally, minimised (e.g. MacCulloch & Di Tella, 2005). For example, in some cultures it may be socially undesirable to be unhappy, or even to be too happy. In relation to East Asian cultures Uchida et al. (2004, p. 226) write that "emphasizing a success of the self may lead to jealousy and envy by others. The personal form of happiness is therefore often perceived to be tainted and incomplete".

This all makes simple comparisons of SWB between nations — and perhaps even between different ethnic groups within nations — problematic, and authors have not always fully addressed these problems. Inglehart & Klingemann (2003), for example, describe surprisingly large differences in SWB ratings between European countries in a paper that barely admits the possibility of cultural variability in interpretation and reporting¹⁴.

On the other hand, there are ways around this issue. Studies limited to relatively local areas or relatively homogeneous cultural groups can produce interesting and valid data. Panel data can allow comparative analysis of SWB trends over time (at least if we can assume certain commonalities in the shapes of different countries' reporting functions)¹⁵. Biological markers such as saliva cortisol levels or heart rate — to be discussed in section 2.3 — might help us to calibrate subjective responses cross-culturally (Layard, 2010). And the use of anchoring vignettes (King et al., 2004), which attempt to correct for differences in reporting functions between individuals, may prove informative, at least for the less subjective end of the spectrum of SWB questions.

Response bias The probability of obtaining any response to a SWB question may also vary from individual to individual. SWB questions generally receive very few missing responses relative to other survey items (e.g. Ferrer-i-Carbonell & Frijters, 2004, p. 654), but the surveys of which they are a part tend, like all surveys, to attract response rates well short of 100%. Those who do not respond may be different in ways that are important for our understanding of SWB, at least at the population level. In the notation used above, the probability of even observing R may depend on x . For example, it is plausible that depressed people would be less likely to participate in social research, and that standard telephone and face-to-face survey methods might well attract respondents who are unrepresentatively lonely and/or trusting, both of which characteristics tend to correlate highly with SWB ratings.

Finally, if it is a social norm to be happy (unhappy), SWB responses — at least in survey modes that are not self-completed — might be biased upwards (downwards). MacCulloch & Di Tella (2005, p. 371) find little evidence that this occurs, however.

2.2.1.4 Dimensionality and boundedness

Some writers have questioned whether SWB is reducible to a single dimension, and thus whether it is meaningful to ask — as single-item SWB questions often do — for a global evaluation of

¹³Littlewood's example concerns "blood feuding clans in Northern Albania where the feud is regarded as a normal, even laudable and enjoyable, enterprise: families with a recently-killed member appeared to mourn only briefly and slightly... But on close questioning the women of the community, while subscribing to the public male ethos of the feud, would privately confide their distress".

¹⁴These authors dismiss the possibility of "translation problems" on the basis that the German-, Italian- and French-speaking Swiss report different levels of happiness than the Germans, Italians and French (Inglehart & Klingemann, 2003, p. 167). All this fact really demonstrates is that the differences in reported happiness between European nations are not exclusively due to language. Using similar data, Layard (2003) notes that all three Swiss groups report similar levels of happiness to each other. But this does not rule out the possibility that differences in both their actual levels of happiness and their interpretations of the question serve to cancel each other out. And even if that were ruled out, extrapolating from this evidence to the much greater diversity of all the world's cultures seems weak, at best.

¹⁵However data from successive time periods could be unreliable over the long term if the meanings of words are not fixed. For example, Carlyle noted that economics was not a "gay science" (1849, p. 530); we would not now consider asking respondents how gay they feel. There is evidence of change in the meaning of 'wellbeing' too (Littlewood, 2008, pp. 2 – 3).

happiness, wellbeing, or satisfaction with life. [Annas \(2004, p. 46\)](#) gives an example: “Suppose that you have just won the Nobel Prize; this surely merits the smiliest face. But suppose also that you have just lost your family in a car crash; this surely warrants the frowniest face. So, how happy are you? There is no coherent answer”. But although such an extreme example illustrates the problem clearly, real experience is rarely like this: affect is much more typically bipolar (happy – sad) ([Larsen et al., 2001](#))¹⁶, and the great majority of people have no difficulty in answering along one dimension ([van Praag & Ferrer-i-Carbonell, 2008, p. 80](#)).

The boundedness of typical SWB scales has also been criticised. [Wilkinson \(2007, p. 10\)](#), for instance, imagines: “there will be a point at which the entire population has finally climbed into the top happiness bracket. From that moment forward, average happiness must remain flat, simply as an artifact of the bounded scale, even if people continue to become happier”. Philosophically, such an argument presupposes that the *experience* of SWB is *not* bounded, and that people cannot therefore know how happy it is possible to become — an assumption that is at least open to doubt ([Thompson & Marks, 2008, p. 18](#)). This issue is also raised on a more practical level, in relation to analyses of longitudinal data where a bounded dependent SWB variable is regressed on potentially unbounded explanatory variables such as GDP. [Johns & Ormerod \(2007, p. 33\)](#), like [Wilkinson](#), argue that a genuine correlation between experienced SWB and GDP could go undetected in such analyses because of a ceiling effect, and suggest that this could be behind the SWB flat-line in [Easterlin’s](#) seminal paper on the subject (1974).

There are a number of counter-arguments to this: first, bounded variables can and do show time trends (fear of crime and social trust, for example, have varied over the recent past — [Dittmann, 2005](#); [Putnam, 1995](#)); current data (in this case, ESS Round 3) place median SWB ratings at 7 out of 10 and have fewer than 1 in 10 respondents answering in the top bracket, which suggests substantial room for upward movement; and analysis of bounded SWB time-trends against unbounded indicators is just one of many strands of SWB research. Finally, *unbounded* SWB scales are not impossible in principle — for example, marketers sometimes use an ‘unbounded write-in scale’ where respondents make a number of marks of their choosing ([Stapleton & Edmonds, 2005](#)); alternatively, a scale could be developed using reference points that are not at the extremes.

2.2.2 Analysing happiness

As discussed in [subsection 2.1.1](#), the basic model underlying most SWB research relates an individual’s reported happiness r to a vector of characteristics x , via a happiness or utility function H and a reporting function R : $r = R(h)$, $h = H(x)$. The reporting and the underlying experience of happiness can rarely be disentangled, so R and H are commonly collapsed into a single function mapping x to r .

The techniques used to estimate a particular model from the data depend on three factors. First, what questions are to be addressed? Economists are usually interested in determining whether and how much particular factors affect SWB — commonly with a special focus on income measures and (un)employment, while controlling for other impacts. Second, what data sets are available? Are these at the micro (individual) level, or aggregated (for example, by country); do they comprise cross-sectional, time-series, or panel data; what SWB items are included, what scales are the responses given on, and what other data is available for analysis? Third, and finally, what assumptions can reasonably be made regarding the SWB variables and the explanatory variables (both observed and unobserved)?

Of course these factors, and the statistical methods that follow from them, are in practice at least partially co-determined. In particular, one element of the development of the field has been the development or application of new statistical techniques in order to relax some of the more restrictive (and potentially unrealistic) assumptions required by earlier techniques.

2.2.2.1 SWB variable treatment and econometric models

The interpretation of SWB responses is one of the key subjects about which differing assumptions can be made. There are three main assumptions, of increasing restrictiveness, which are associated

¹⁶[Larsen et al. \(2001, p. 684\)](#) explain: “positive and negative affect are separable and... mixed feelings of happiness and sadness can co-occur... [M]any participants surveyed immediately after watching the film Life Is Beautiful, moving out of their dormitories, or graduating from college felt both happy and sad... [A]lthough affective experience may typically be bipolar, the underlying processes, and occasionally the resulting experience of emotion, are better characterized as bivariate.”

with a variety of different models (Ferrer-i-Carbonell & Frijters, 2004, p. 643):

- A1. Reported SWB is a positive monotonic transformation of an unobservable underlying quantity of interest: $R' > 0$.
- A2. Reported SWB is ordinally comparable between people: if $r_i > r_j$ then $h_i > h_j$, where subscripts i and j represent different individuals.
- A3. Reported SWB is cardinally comparable between people: $h_i - h_j = \omega(r_i, r_j)$, where the function $\omega(\cdot)$ is known up to a multiplicative constant; $h_i - h_j = r_i - r_j$ is commonly assumed.

Cardinal SWB comparability Under the cardinality assumption, A3, simple OLS regressions are appropriate¹⁷. If a panel data set is available, the use of OLS makes it straightforward to include individual fixed effects (or use first differencing) to control for time-invariant unobserved influences on SWB (Ferrer-i-Carbonell & Frijters, 2004).

OLS models have been widely used in the psychology literature. In earlier research, happiness economists tended to turn to them principally when the use of aggregated (mean) SWB ratings forced them to assume cardinality in any case (*ibid.*) — see, for instance, Welsch (2002). However, several more recent studies have shown OLS results to be qualitatively indistinguishable from the results of models not requiring cardinality (e.g. Moro et al., 2008), and OLS models may then be preferred because of the straightforward interpretation of the coefficients.

The subjectivity of SWB makes it difficult to assess the realism of the cardinality assumption. Schwarz (1995) argues that respondents strive to make responses informative, and van Praag (1991) argues that respondents may try to distribute reporting categories evenly with respect to the possible values of an underlying, unobservable quantity in order to maximise the information conveyed (Ferrer-i-Carbonell & Frijters, 2004). Although these psychological arguments are undoubtedly highly speculative, results obtained using models that do and models that do not assume cardinality are usually extremely similar (*ibid.*).

Ordinal SWB comparability Relaxing the assumption of cardinality and turning to ordinal comparability, A2, many researchers have used the standard ordered probit and logit models. These models treat ordinal data ($r = 1 \dots J$) as the discrete expression of a continuous latent variable of arbitrary scale. On this basis they estimate two sets of parameters using maximum likelihood: first, a coefficient vector used to predict the latent variable from the explanatory variable vector (x); and second, a set of $J - 1$ cut-points, which are the values of the latent variable where there is a change in the observed discrete rating.

In empirical economic research with ordinal data, including SWB research, these models “fully dominate the literature” (Winkelmann & Boes, 2009, p. 192). These models do not lend themselves easily to the inclusion of individual fixed effects for panel data (to control for heterogeneity in individual happiness and/or reporting functions), however; fixed effects specifications have therefore been rather little used in the economic literature to date (Ferrer-i-Carbonell & Frijters, 2004).

Generalised ordered models The standard ordered models assume (as OLS does) that the relative magnitudes of the effects of each of the explanatory variables are constant across the distribution of outcomes (Boes & Winkelmann, 2006a, p. 5). For example, the impact of income relative to the impact of marriage or divorce must be the same for those with low and high SWB levels alike. This is variously termed the proportional odds, parallel lines or parallel regression assumption.

Boes & Winkelmann (2006a) argue that single-scale SWB measures may be understood as measuring both unhappiness ('negative wellbeing') at the lower end and happiness ('positive wellbeing') at the higher end¹⁸ and that, since different factors may have different effects on these two

¹⁷ Alternatively, if respondents are thought to answer scale questions by the rounding up or down of a continuous latent quantity, interval regression would be suitable (van Praag & Ferrer-i-Carbonell, 2008, p. 36). For example, a response of 9 would suggest an underlying value for interval regression of 8.5 – 9.5; a response of 10 would suggest an underlying value of 9.5 or higher. Interval regression has not been widely used in the literature, however.

¹⁸This recalls the discussion in subsubsection 2.2.1.4.

dimensions, the parallel regression assumption might need to be relaxed. While the multinomial logit could be employed for this purpose, discarding information about the ordering of the response scale, this is inefficient. Instead, researchers have turned to generalised ordered response models (Williams, 2006; Boes & Winkelmann, 2004, 2006b; Boes, 2007; Fu, 1997), principally the generalised ordered logit and probit¹⁹.

These generalised models effectively estimate a separate vector of coefficients for each cut-point of the latent variable (Boes, 2007, p. 126); they give results that are similar to those of a series of binary logits or probits, taking each response level in turn and grouping responses on either side of it (Williams, 2006, p. 59)²⁰. A *partial* proportional odds model is also possible, and potentially the most useful variant: this is effectively a hybrid of the standard and generalised models, in which the parallel regression assumption is imposed on certain explanatory variables, which then take a single coefficient throughout the outcome distribution, but not on others (this can be automated by a stepwise process using likelihood-ratio tests). Applications of this model to BHPS and GSOEP data²¹ (with the inclusion, in some cases, of random effects) potentially vindicate concern over the parallel regression assumption; they suggest, amongst other things, that higher incomes may have a significant *negative* effect on the probability of answering in the very topmost SWB category (Mentzakis & Moro, 2009; Boes & Winkelmann, 2004, 2006a; Winkelmann & Boes, 2009).

Probit-adapted OLS Van Praag & Ferrer-i-Carbonell (2008, p. 28) note that the standard ordered logit and probit models implicitly cardinalise SWB through the cardinal continuous latent variable underlying them, and on this basis suggest a method they term probit OLS or probit-adapted OLS. The probit-adapted OLS is a simple OLS model using a ‘rough cardinalisation’ of the ordinal SWB variable: a transformation such that the new dependent variable takes the conditional mean (given the original ordinal rating) of a standardised normally-distributed continuous variable, calculated based on the frequencies of the ordinal ratings in the sample (Cornelißen, 2006, provides a worked example). Where the assumption of normality in the continuous variable holds — and in van Praag & Ferrer-i-Carbonell’s examples, the results suggest it does — probit-adapted OLS is equivalent to the ordered probit. Its advantage is that it is quicker to compute and can be used as a building block in more complex models. It does not appear to have been very widely used, although its results are reported by Luechinger (2009) and Stevenson & Wolfers (2008).

Limited SWB comparability Abandoning or weakening the assumption of ordinal comparability is possible using techniques only relatively recently applied to SWB (there appears to be significant potential for the wider application of all of the following methods).

Ferrer-i-Carbonell & Frijters (2004) develop and apply an ordered logit model with fixed individual effects and individual-specific thresholds. They find that inclusion of time-invariant individual effects qualitatively changes the results of their model; this contradicts the finding of Clark & Oswald (2002, p. 12), whose cardinal models suggest that “cross-section and panel equations seem to have similar general structures”.

Clark et al. (2005) assume that different groups or types of individuals have different happiness and/or reporting functions (which cannot be separated using their data), and hence estimate an ordered latent class model in which the classes vary both in the marginal contribution of income to SWB and in the cut-points used to translate a latent continuous variable into observed SWB ratings. Their data identify 4 or 5 classes with significantly different reported happiness functions, suggesting that inter-individual heterogeneity is more complicated than can be fully modelled by simple fixed effects.

Ferrer-i-Carbonell (2005) estimates SWB effects of an individual’s own and reference group income using an ordered probit model with individual random effects (allowing for correlation between the random effects and a subset of explanatory variables using the Mundlak correction). The results are consistent with findings from cross-sectional methods: own income has a small but significant effect on SWB.

¹⁹Boes & Winkelmann (2004; 2006b) and Winkelmann & Boes (2009) also describe a sequential ordered model and a finite mixture model; these are not discussed further here.

²⁰For clarification, this grouping would proceed as follows. First, the lowest response ($r = 1$) is contrasted with all higher ones ($r = 2 \dots J$); next, the lowest two responses ($r = 1, 2$) are contrasted with all higher ones ($r = 3 \dots J$); and so on. Finally, all responses but the highest ($r = 1 \dots J - 1$) are contrasted with the highest one ($r = J$).

²¹The BHPS and GSOEP are respectively the British Household Panel Survey and the German Socio-Economic Panel.

Anchoring vignettes Data sets in which anchoring vignette items are included alongside an SWB self-assessment permit two further approaches to correcting for differing reporting functions (R) across individuals, given two key assumptions (King et al., 2004). The assumptions are: vignette equivalence, which means different respondents need to understand the vignettes in the same way; and response consistency, which means that respondents need to use the response scale for the vignettes and for their self-assessment in the same way.

A non-parametric transformation of the original ordinal SWB response into a new (potentially vector-valued) ordinal variable can be made (e.g. Lau, 2007). This can then be analysed with a variant of the standard ordered logit or probit which allows vector-valued ordinal responses. Alternatively, a parametric technique — compound hierarchical ordered probit (chopit) — can be used. This predicts individuals' cut-points on a latent continuous variable based on both their vignette responses and the values of independent variables, and does not require that every respondent answer the vignette items (Rabe-Hesketh & Skrondal, 2002; King et al., 2004).

Using the chopit model with the Survey of Health, Ageing and Retirement in Europe (SHARE) data set — the only known study incorporating vignettes for SWB — Angelini et al. (2008) find that higher life satisfaction ratings among Danish as compared to Italian retirees may be largely explained by differing interpretations of the response scale.

2.2.2.2 Explanatory variable treatment

While the nature and appropriate treatment of the SWB data has been debated at length, comparatively little attention has been given to the treatment of explanatory factors in SWB research. Explanatory variables are generally entered into models in a linear specification, save for income (usually logged) and age (usually in linear and quadratic forms). Most researchers have also assumed the effects of different explanatory variables to be independent, and potential interactions have not been widely explored (for example, could the SWB effect of having — or not having — children be partly contingent on age and gender?)²².

Although several analyses incorporate spatially-derived data (e.g. Luechinger, 2009; MacKerron & Mourato, 2009; Brereton et al., 2008), only two so far seem to have attempted the econometric modelling of any spatial effects (Rehdanz, 2007; Stanca, 2010). Relevant spatial models could include: spatial explanatory variables models (in which a person's SWB is correlated with other observed characteristics of nearby individuals); spatial error models (in which SWB is correlated with unobserved characteristics of nearby individuals); spatial lag models (in which SWB is correlated with the SWB of nearby individuals); and models accounting for spatial heterogeneity in the relationships between variables. The lack of use of spatial models in economic SWB research to date may be at least partly explained by the relative scarcity of data that are spatially referenced at an appropriately high resolution. Spatial models could also be applied to relations in conceptual spaces, such as social networks (where by 'nearby', one means 'well known' or 'strongly related'), as they have begun to be in the medical literature (Fowler & Christakis, 2008; Christakis & Fowler, 2009).

Finally, the degree of inter-correlation between many of the more important factors influencing SWB (such as age, income and employment) might suggest the use of techniques such as structural equation modelling (SEM) or principal components analysis (PCA), but these have not been widely used (although for SEM using domain satisfactions data, see van Praag et al., 2003).

2.2.2.3 Causality

Establishing causality, especially with cross-sectional data, is a particularly difficult problem in happiness research. Happiness and wellbeing are such all-encompassing ideas that it is often difficult to be sure that happiness is not a cause of another variable (rather than, or as well as, being caused by it); or that an unobserved variable is not a cause of happiness (leading to omitted variables bias); or even that an *observed* variable does not cause happiness (for the purposes of an instrumental variables treatment, for example).

Studies using aggregated data — usually mean SWB ratings at a whole-country level alongside other aggregated statistics such as GDP, or mean air pollution levels — are potentially subject to

²²Yang (2008b; 2008a) looks at interactions with life-course variables such as age and would represent an exception here, but writes outside of economics.

the ‘ecological fallacy’ (the spurious inference of individual-level characteristics from group-level characteristics) (Robinson, 1950), and face particular difficulties in establishing causality. And individual-level data sets, which have usually not been collected specifically for the study of SWB, generally omit some things which might reasonably be expected to have a significant impact — such as personality indicators, childhood experiences, traumatic events, or being in a relationship (even if unmarried) — and which might not be independent of the variables that are the focus of the investigation.

Fixed effects treatments with panel data can of course help with some of these factors — for example, genetic elements of SWB are fixed by definition, and other personality traits can be reasonably assumed to be broadly stable — but even with panel data, omitted time-variant variables may be a problem. For example, “income movements and wellbeing movements may merely be linked because of omitted variables (such as seniority in the workplace)” (Gardner & Oswald, 2007, p. 50). As usual, the most robust evidence of causality is provided by natural experiments, in the form of exogenous shocks such as lottery wins (*ibid.*) or political shifts (Frijters et al., 2004). Also as usual, natural experiments are not easy to identify, although the conclusions of the two studies cited, which focus on income, are encouragingly consistent with the broad consensus in the literature.

2.2.3 Valuation

If SWB can be regarded as a proxy for PS-style utility, SWB model estimates can be used for monetary valuation. For example, Blanchflower & Oswald (2004, p. 1373) use models estimated on US General Social Survey data to calculate dollar values for life events like unemployment and divorce, finding that “a lasting marriage (compared to widowhood as a ‘natural’ experiment)... is estimated to be worth \$100,000 a year”.

2.2.3.1 Method

Ferreira & Moro (2010) provide an extended discussion of the SWB valuation method, on which the following account is based. The usual SWB regression specification in the literature is a simple additive model in which income is logged. For example, for reported SWB r , income y , and a good g :

$$r = \alpha + \beta \ln(y) + \gamma g$$

From this, the implicit price of the good g — which is the marginal rate of substitution between the good and income y — is obtained at the mean wage \bar{y} as:

$$\frac{\delta r / \delta g}{\delta r / \delta y} = \gamma \frac{\bar{y}}{\beta} \quad (2.1)$$

The welfare effect of a discrete change in the good can also be measured in terms of the compensating or equivalent surplus.

Compensating surplus The compensating surplus c is the sum of money that would keep an individual at his or her original level of utility after a change in the provision of the good. It is calculated following a standard SWB regression estimation as follows.

Before the change, reported SWB r_0 is modelled as a function of income y and the good g_0 :

$$r_0 = \alpha + \beta \ln(y) + \gamma g_0$$

Following a change in the provision of the good to g_1 , reported SWB r_1 becomes:

$$r_1 = \alpha + \beta \ln(y) + \gamma g_1$$

The compensating surplus c is thus defined so as to satisfy:

$$r_0 = \alpha + \beta \ln(y - c) + \gamma g_1$$

Substituting r_0 produces:

$$\beta \ln(y) + \gamma g_0 = \beta \ln(y - c) + \gamma g_1$$

Which rearranges to give, at mean income \bar{y} :

$$c = \bar{y} - \exp\left(\ln(\bar{y}) + \frac{\gamma}{\beta}(g_0 - g_1)\right) \quad (2.2)$$

Equivalent surplus The equivalent surplus e is the amount of money that, if a particular change in the provision of the good were *not* to occur, would bring an individual the utility level they would have attained if that change had in fact taken place. It is calculated similarly, by setting:

$$r_1 = \alpha + \beta \ln(y + e) + \gamma g_0$$

To give, at mean income \bar{y} :

$$e = -\bar{y} + \exp\left(\ln(\bar{y}) + \frac{\gamma}{\beta}(g_1 - g_0)\right) \quad (2.3)$$

The compensating surplus represents maximum willingness to pay (WTP) for an improvement in the good, or minimum willingness to accept (WTA) for a deterioration. Conversely, the equivalent surplus represents maximum WTP to avoid a deterioration in the good, or minimum WTA to forgo an improvement (Brookshire et al., 1980).

2.2.3.2 Relation to hedonic pricing

Many applications of the SWB valuation method in the literature to date have been to environmental goods. Spatial characteristics of this kind have traditionally often been valued using hedonic analysis.

An important insight of hedonic theory is that — assuming housing and employment markets in perfect equilibrium — local wages and rents will vary with location characteristics such that the utility an individual can achieve is constant across locations. If this were not the case, some individuals would be made better off by moving (Roback, 1982). This insight is commonly formalised with a function for indirect utility v in location k , with wages w , rents l and constant c , of the following form:

$$v^k = v[g^k, w(g^k), l(g^k)] = c \quad \forall k \quad (2.4)$$

In SWB valuation, a reported happiness variable is used as a proxy for the latent utility variable v . A simple regression of happiness on the level of an environmental good then provides the total derivative, $\frac{dv}{dg}$. In equilibrium, for the reasons outlined above, this is expected to be zero (Ferreira & Moro, 2010). Some studies have taken this approach to computing a good's 'residual shadow cost' in markets that are significantly *out of* equilibrium. For example, van Praag & Baarsma (2005, p. 150) calculate this quantity for airport noise in Amsterdam, identifying it as the "amount that should be compensated for, if authorities decide to compensate". This type of analysis might be described as complementary to traditional hedonic valuation.

Conversely, to recover the partial derivative $\frac{\delta v}{\delta g}$ and thereby calculate the full value of the good, rents and wages must be held constant; that is, they must be controlled for in the regression specification (Luechinger, 2009; Ferreira & Moro, 2010). In this case, an income variable is sometimes used as a wage proxy (e.g. Ferreira & Moro, 2010). This kind of analysis might be used as an alternative to hedonic valuation methods²³.

²³Frey et al. (2010, p. 150) suggest disagreement in the literature as to whether SWB valuation represents an alternative or a complement to more traditional hedonic analyses but, as seen here, it is potentially capable of playing either role. There is also a broader sense in which either form of SWB valuation can be seen as complementary to hedonic analyses, since the use of two different methods, having different strengths and weaknesses (as noted below), may produce more robust results.

2.2.3.3 Strengths and weaknesses

Frey (2008b), Welsch & Kühling (2009), Ferreira & Moro (2010) and Fujiwara & Campbell (2011) all provide summaries of the strengths and weaknesses of the SWB valuation method as compared with the conventional alternatives: revealed and stated preference techniques. In general, SWB valuation is presented as a complement rather than an alternative to conventional valuation techniques, on the basis that it has quite different strengths and weaknesses.

Revealed and stated preference methods ultimately rely on the PS foundations outlined in subsection 2.1.1, which require that individuals are able to accurately predict the utility implications of (actual or hypothetical) choices. Research in behavioural economics lays these foundations open to considerable doubt (see subsection 2.4.2), leading Fujiwara & Campbell (2011, p.39) to argue that the main appeal of SWB valuation is “that it does not rely on people having well-defined pre-existing rational preferences” (see also Kahneman & Sugden, 2005).

Revealed and stated preference methods are subject to further limitations. Stated preference responses may be subject to framing effects, anchoring, scope insensitivity, neglect of substitutes or the budget constraint, strategic behaviour, the “warm glow” effect of supporting a good cause, and protests (against the valuation exercise, the proposed payment mechanism, and so on). Stated preference studies may also be very costly to run. Hedonic pricing — a common revealed preference method — relies on the assumption that labour and housing markets are in equilibrium, and hence that these markets are unrestricted; that there is a wide variety of houses and jobs; that individuals know the relevant characteristics of all locations; that prices adjust immediately; and that transacting and moving are costless. These assumptions are unlikely to be fully met.

Valuation with SWB data does not suffer from these specific weaknesses. On the other hand, the method requires strong assumptions of its own. Crucially, as noted above, we must accept some particular SWB indicator as a proxy for PS-style underlying utility. As noted in subsubsection 2.2.1.1, a variety of concepts and indicators of SWB exist. In the context of valuation studies, LS measures have been the most frequently used. Fujiwara & Campbell (2011) argue that these have implicitly been assumed to most closely resemble the conventional PS notion of utility, noting also that using LS as the SWB measure produces lower value estimates, since income tends to correlate more strongly with life satisfaction than with other indicators. In this connection, Powdthavee & van den Berg (2011) find that values calculated for health conditions can vary substantially — in some cases, by orders of magnitude — depending on the indicator used, with LS producing the lowest values.

SWB valuation imposes some further requirements. Practically, we must be assured of the quality of the SWB indicator and of the survey data of which it is a part, bearing in mind the issues discussed in subsection 2.2.1. We must be persuaded that the SWB regression model takes the correct functional form, and that the relationships between the explanatory variables and SWB are causal. And we must be wary of assortment by tastes: for example, when valuing air pollution, it may be that less pollution-sensitive individuals live in more polluted locations (and vice versa), leading to underestimation of SWB impacts and the associated monetary values (Luechinger, 2009, p. 493).

Unlike stated preference methods, SWB data cannot be used to value characteristics outside of their observed (past and current) range. Although SWB valuation may be able to capture certain non-use values, such as for regional biodiversity (Rehdanz, 2007; Ferreira & Moro, 2010), it will not necessarily do so, since the simple existence of a good may not vary between individuals surveyed (Fujiwara & Campbell, 2011).

Income As seen above, the effect of income on wellbeing is a key parameter in SWB valuation calculations. To date, most studies using the SWB valuation method have reported values that “seem too large” (Ferreira & Moro, 2010), and researchers have generally supposed the cause of

this to be an underestimation of the income effect. This underestimation, in turn, may have a wide range of causes.

First, the coefficient on income may be biased downwards by measurement error, caused by wide response brackets (Frey et al., 2004) or missing, misleading or mistaken responses on income-related survey questions, or potentially by a failure to correct for household size²⁴.

Second, the omission of respondents' own lagged incomes or of the incomes of others may give rise to the same effect. As Welsch (2009) notes, "since, due to adaptation, lagged income affects life satisfaction negatively [...], and current income is positively correlated with lagged income, omission of lagged income may imply a downward bias in the estimate of the marginal utility of (current) income". Assuming that one's income is also positively correlated with the other incomes against which one compares it, a similar argument may be made in regard of the omission of appropriate comparator incomes²⁵.

Third, the effect of income may be underestimated due to a failure to account for costs of income generation, such as working hours, commuting, and stress. To address this issue, income may be instrumented, for example with the income of other household members and industry/occupation data (Luechinger, 2009). However, as Luechinger notes, a predicted income measure of this sort is also a good candidate for a comparator income estimate.

Fourth, there may be simultaneous causation, such that being happier leads to increased earnings as well as the reverse (e.g. Clark et al., 2008b, p. 113).

Finally, indirect impacts of income on SWB may be absorbed by other explanatory variables, such as health — Dolan et al. (2011, p. 8) find the literature "remarkably silent on this matter", and suggest a practical method for countering it.

2.3 Is happiness valid economics?

Despite the growth of SWB research within economics, it is not currently a fully mainstream approach²⁶. It continues to attract varying degrees of scepticism from within the PS tradition — perhaps unsurprisingly, given the historical roots of the two approaches. For example, Smith (2008) writes: "I am 'unhappy' with happiness economics... It is amazing to me that the best economics journals have devoted so much attention to what Dan Hamermesh (2004) has previously described as 'rather silly' analyses". Most criticism can be classified into three major levels, which are decreasingly fundamental: the epistemological, the practical, and the disciplinary.

First, epistemologically, it is held that subjective experiences are ultimately unmeasurable and incommensurable: I can never prove that my experience of "yellow" is the same as yours (Gilbert, 2006), and the same goes for happiness concepts of all kinds. This, of course, is the very same observation that turned 19th century economists away from subjective accounts of wellbeing. In principle, it is inescapable; in practice, for much of the time, it seems to matter very little.

There are many sources of evidence that SWB reports are meaningful, and that different people mean similar things by them. Current happiness or satisfaction is a strong predictor of future behaviour (Clark et al., 2008b, p. 136). It correlates strongly with objective indicators including neural activity (measured with magnetic resonance imaging), heart rate, blood pressure, smiling and suicide, and subjective data including recall of positive and negative events and others' SWB assessments — MacCulloch & Di Tella (2005, pp. 370 – 371) summarise these connections concisely. State-by-state variation in US SWB levels is also substantially correlated with compensating differentials calculated using objective quality-of-life data (Oswald & Wu, 2010; Gabriel et al., 2003). Especially given our evolutionary/genetic similarity to each other, none of this should seem terribly surprising (Veenhoven, 2004).

²⁴For example, Moro et al. (2008) specify the SWB regression to include household income (logged) and dummies for number of children, but do not include household size or use a correspondingly equivalised income measure. Unusually, they also do not find a positive effect of marriage or cohabitation — perhaps because these dummy variables also serve as indicators of lower income per household member.

²⁵However, as will be noted in subsubsection 2.5.1.2, it is not necessarily clear which the appropriate comparator incomes are.

²⁶Please note that the 'mainstream' is not here equated directly with the neo-classical orthodoxy presented in caricature above, nor is it suggested that it is a single, static, or easily-defined quantity; like the core of any discipline, it is in constant flux (Colander et al., 2004).

Second, practically, it is argued that even if it is possible to use SWB data, various measurement issues will bias the results, particularly where a subjective measure is used as a dependent variable. Bertrand & Mullainathan (2001) offer a clear statement of this position; they are especially pessimistic, in terms of the notation introduced in subsection 2.1.1, regarding the independence of $R(\cdot)$ and x . The availability of longitudinal or panel data offers some reassurance in relation to such criticism, however, since individual fixed effects can be used to control for the time-invariant elements of any such relationship (Frey & Stutzer, 2002b).

And third, in disciplinary terms, it is suggested that while SWB analyses represent a valid and even interesting line of inquiry, it is not one to be pursued within economics. Hamermesh (2004) elaborates: “we should not abandon our comparative advantage — our frameworks for analysing maximising behaviour by individuals and how that behaviour affects individual and group outcomes”. Conversely, happiness economics has drawn interest from those expressly calling for a broadening of disciplinary scope: pluralist, heterodox and ‘post-autistic’ movements (e.g. Guerrien, 2004; Fullbrook, 2005; George, 2007; Kaskarelis, 2007).

Hamermesh (possibly alongside some of the more radical post-autists) arguably presents a false choice here. Accepting SWB research as a useful endeavour need not imply abandoning other analytical frameworks (Diener et al., 2009, p. 3). Indeed, one of the strongest arguments in favour of the application of SWB methods is that their strengths *and* weaknesses are quite different from — and even complementary to — the strengths and weaknesses of methods recently favoured in the mainstream (Welsch & Kühling, 2009; Ott, 2010). For example, non-market valuation methods based on SWB scores require a quite different set of assumptions and simplifications than more established revealed- and stated-preference methods. They can therefore offer corroboration (or otherwise) of those other methods’ results, or be applied where those methods’ assumptions are plainly inapplicable.

Ultimately, the status of SWB research is a matter of shifting social consensus within the discipline; any attempt to put the issue on firmer ground appears likely to turn out rather circular (a problem that is concisely encapsulated in the popular definition of economics as ‘what economists do’ — Backhouse et al., 1997, p. 2).

2.4 Who are the happiness economists?

There are not, or at least were not until recently, any dedicated ‘happiness economists’. Happiness economics has been done by people in various areas — and on various edges — of the discipline²⁷. One may therefore ask which areas of economics, and which economists, have been most closely associated with which aspects. Three major areas are outlined below — as well as one area more notable by its absence from this field.

2.4.1 Macroeconomics: growth, national accounting, unemployment and taxation

As noted above, Easterlin’s (1974) paper, ‘Does economic growth improve the human lot?’, is often cited as an early (re)introduction of SWB into economics. Connections between income and happiness at the national and international scales have since been a important strand of happiness research (e.g. Oswald, 1997; Hagerty & Veenhoven, 2003; Blanchflower & Oswald, 2004; Brockmann et al., 2008), and one which has obviously close ties with work looking at income and happiness on the individual level (e.g. Easterlin, 2001; Boes & Winkelmann, 2006a; Layard et al., 2008).

The macro-level research has naturally also led to consideration of SWB as one of the alternatives — or complements — to GDP as an index of national or social ‘progress’ (e.g. Diener & Seligman, 2004; Kahneman et al., 2004a; Di Tella & MacCulloch, 2008). In this form — perhaps most famously championed by the Bhutanese government, with its measures of Gross National Happiness (GNH) — it has been of substantial interest to other governments and politicians (see section 2.6). SWB measures also feature within composite indicators such as the New Economics Foundation’s ‘Happy Planet Index’ (Marks et al., 2006a; Thompson et al., 2007). Of course, any aggregated

²⁷In addition, of course, to being influenced by and indebted to those working in other disciplines, most notably psychology (e.g. Cantril, 1965).

indicator of social well-being raises challenging questions in relation to social welfare functions and utilitarian ethics (again, see section 2.6).

Still at the macro level, the aggregate impacts of (un)employment, inflation and tax policy have been studied in some depth (e.g. Clark & Oswald, 1994; Layard, 2005b; Blanchflower, 2007; Clark et al., 2008a). Rivalry, habituation, and other psychological and sociological factors are involved in these effects, giving this work strong connections with behavioural economics.

2.4.2 Behavioural economics

Behavioural economics investigates how real economic actors actually behave (make decisions), and seeks to provide explanations — primarily psychological and sociological ones — as to why they behave as they do (e.g. Rabin, 2002). Neo-classical utility theory provides a baseline for comparison with empirical data: behavioural predictions based on rational individual (decision) utility maximisation. Behaviour may deviate from these predictions for reasons such as loss aversion, anchoring effects, and myopia (e.g. Hsee & Hastie, 2006; Kahneman & Thaler, 2006; Offer, 2006; Camerer et al., 2005).

Happiness economics provides an alternative baseline, allowing researchers to assess how far behaviour deviates from that which would appear to have maximised experienced utility or SWB. By recognising a distinction between decision and experienced utility, it permits analysis of a further reason for apparently sub-optimal behaviour: imperfections in individuals' ability to predict their own future experienced utility or SWB under different scenarios. Established examples of such imperfections include over-estimation of the extent to which one's future tastes will resemble one's current tastes ('projection bias' — Loewenstein et al., 2003), and failure to anticipate the extent of habituation to rises in one's income (Layard, 2005b). (The former may lead to over-consumption of durable goods, and the latter to excess pursuit of income and consumption in general, relative to the apparent SWB optima).

Experienced utility or SWB measures also enable behavioural economics to address questions beyond the scope of analyses limited to data on preferences revealed through choices, including examining the contexts of choice and the effects on (experienced) utility of choices made within different choice sets (Koszegi & Rabin, 2008). Such work can indicate, for example, that more choice is not always preferable in SWB terms (Schwartz et al., 2002).

2.4.3 Environmental and ecological economics

As discussed in subsection 2.2.3, one interesting application of SWB data has been to non-market valuation. A particular strength of SWB-based valuation is its applicability to questions where little individual choice is involved, such as mental health or community life (Layard, 2010). Valuation using SWB has so far attracted the attention of environmental economists in particular. The use of SWB for environmental valuation is considered in greater depth in subsection 3.2.3.

Within *ecological* economics — which has, like happiness economics, been somewhat isolated from the economic mainstream to date (Dasgupta, 2008) — SWB is of interest in part because it makes strong sustainability more palatable²⁸. Strong sustainability appears to require future economic growth to rely less on material goods, and/or to proceed at a slower (or even negative) rate (Victor & Rosenbluth, 2007; NEF, 2006). Under the neo-classical PS model, growth in individual and national income is effectively synonymous with growth in individual utility and social welfare. The PS approach therefore appears to predict a rather dismal future under any feasible regime: reduced utility deriving from unintended ecological overshoot on the one hand; intentionally reduced growth, and therefore utility, on the other. But since, at least in theory, growth in SWB could be de-coupled from GDP growth, SWB might offer a theoretical route out of this dismal future (Welsch, 2009; Jackson, 2005; Gowdy, 2005; Dolan et al., 2006; Marks et al., 2006b).

To imagine such a way out requires an emphasis on non-income factors that utility theory typically assumes to be held constant, and which happiness research tends to find are strongly related to

²⁸Strong sustainability proposes limits to the substitutability of natural capital with other forms, and this implies that the scale of resource extraction and of the production of wastes requiring assimilation, relative to the biosphere, is of some importance (the rather unfashionably-expressed proposition of 'limits to growth' (Meadows et al., 1972; Meadows et al., 2004). It is increasingly widely accepted that the scale of certain activities — including in particular the emission of greenhouse gases — is already close to or beyond sustainable limits (Millennium Ecosystem Assessment, 2005; HM Treasury, 2006; IPCC, 2007).

SWB, including family life, social ties and environmental quality. Ecological economists — as well as civil society groups, and policy-makers and their advisers — have therefore become increasingly interested in the relation of happiness to these factors. And ecological and environmental economists are understandably particularly interested in happiness in relation to aspects of environmental quality and their valuation (e.g. van Praag & Baarsma, 2005; Welsch, 2007; Rehdanz & Maddison, 2008; Brereton et al., 2008; MacKerron & Mourato, 2009; Luechinger, 2009), to environmental attitudes and behaviours (Brown & Kasser, 2005; Ferrer-i-Carbonell & Gowdy, 2007), and to the potential disconnection between consumption and well-being (e.g. Csíkszentmihályi, 2000; Sanne, 2002; Layard, 2005a; Scitovsky, 1977)²⁹.

2.4.4 Others

Of course, happiness work has not been exclusive to these areas. For example, the work of the 'Leyden school', led by Bernard van Praag and Arie Kapteyn at Leyden university from the early 1970s (e.g. van Praag, 1968; van Praag, 1971; van Praag & Kapteyn, 1973), is sometimes taken to represent a precursor of or complement to more recent work on SWB (e.g. van Praag, 2006). Although the Leyden school's primary focus has been on financial satisfaction, it has also investigated broader life satisfaction measures — as commonly employed in SWB research — and more general methodological issues around subjective response data (e.g. van Soest et al., 2007; van Praag & Ferrer-i-Carbonell, 2008).

2.4.5 Development (or who *aren't* the happiness economists?)

One area of the discipline which has *not* been a significant incubator for happiness research, despite a shared scepticism regarding the sufficiency of income- or consumption-based welfare indicators, is development economics.

Recent development research has been increasingly influenced by the capability approach described by Sen and others. Capability relates to a person's positive freedom — envisaged as the range and quality of opportunities (or 'functionings') that a person both has reason to value and is able to attain — and as such represents "an unusual intermediary between objective wellbeing and subjective wellbeing concepts" (Gasper, 2007, p. 351).

The problem of habituation or adaptation to bad circumstances (whether through simple conditioning or broader cultural or religious indoctrination) has largely been seen as precluding the use of SWB in development work: "inequalities and exploitations survive in the world through making allies out of the deprived and exploited. The underdog learns to bear the burden... Discontent is replaced by acceptance... the horrors look less terrible in the metric of utilities" (Sen, 1984, p. 309). However, it is possible that this position both overstates the problem of adaptation in relation to SWB and understates it in respect of capabilities (Clark, 2009). Some have even suggested that SWB could encompass rather than compete with capability in the evaluation of poverty (Kingdon & Knight, 2006).

Of the wellbeing ideas discussed in this chapter, capability probably shares most with the objective lists account (see Dolan & White, 2007), and the relationship between capability and more subjective wellbeing accounts is not straightforward. Comim (2005, p. 162) sees a "remarkable" lack of mutual acknowledgement between the two literatures, and describes some key contrasts: while capability draws principally from moral and political philosophy, SWB has a primarily neurological/psychological/sociological base; capability assessments privilege qualitative aspects, whereas SWB's empirical approach is almost exclusively quantitative; and where capability admits of normative 'anchors' for assessing wellbeing — anchors such as autonomy and fairness — SWB has no obvious normative content beyond standard utilitarianism.

²⁹The more radical end of the SWB and consumption literature, drawing on work from psychology, suggests that the economic and social system in developed economies is partly predicated on a level of structural or manufactured dissatisfaction, in more-or-less direct opposition to SWB. Such dissatisfaction, in which advertising plays an important role, helps to ensure that people remain motivated to consume (e.g. Kasser, 2002; Jackson, 2004; Kasser et al., 2007).

2.5 What does happiness economics tell us?

In general, the literature gives a fairly consistent picture of which factors have what associations with SWB. Where studies' findings do contrast, an important cause may be endogeneity, in that one (or both) of the studies fails to control for correlated explanatory factors³⁰. Since several authors have reviewed the specific findings of the SWB literature in detail (e.g. Frey & Stutzer, 2002a; Dolan et al., 2008), we touch on this topic only briefly.

2.5.1 Income and wealth

The impact of income measures on SWB has, as stated above, been a major focus of the SWB literature. This may be due in part to the centrality of the income/SWB relationship when using SWB data for monetary valuation. Researchers have investigated absolute income, income relative to others', and income relative to past income. Clark et al. (2008b) provide a detailed survey.

2.5.1.1 Absolute income

In general, absolute income is found to have a significant and positive association with individuals' SWB, but one whose magnitude is dwarfed by the effects of other factors (such as health, labour market status and marital status), at least in developed countries. There is perhaps surprisingly little discussion in the literature regarding the appropriate measure(s) of absolute income: this could be individual income, household income, or equivalised household income (adjusted for household size and composition).

Most studies use a log income measure as the explanatory variable, and thus assume that marginal utility is inversely proportional to income (or equivalently, that the elasticity of marginal utility with respect to income is unity). Testing this assumption, Layard et al. (2008) assume only that the elasticity of marginal utility with respect to income is constant, and find that it is in fact somewhat greater than unity — so that, for example, someone with an income of \$10,000 has *more than* ten times the marginal utility of someone getting \$100,000³¹. Studies making use of exogenous income variation, such as lottery wins, have helped to establish that the apparent impact of income on SWB is at least partly causal (e.g. Gardner & Oswald, 2007)³².

Implications The relatively small effect of absolute income measures on happiness has been one of the more interesting findings in the literature and — given the emphasis placed on income in the standard economic account of wellbeing as preference satisfaction — one that has seemed to demand explanation. One line of reasoning is that consumption is ultimately the quantity of interest under the preference satisfaction approach, and that reported income is a noisy and biased proxy, excluding goods provided by the State and deferred consumption via savings (Clark et al., 2008b, p. 111). Based on Australian survey data including items on net worth, Headey & Wooden (2004, S24) conclude that wealth “is at least as important to well-being and ill-being as income”. An additional and more widely studied explanation is that the emphasis on absolute income within the preference satisfaction account neglects the more important contribution of relative income measures.

³⁰For example, the effects of gender and care-giving, of religion and sociable group attendance, of age and wealth, or equivalised household income and family size, could each be correlated; hence a study that did not control for wealth might well report a different relationship between age and SWB than one that did.

³¹They assume $u = \begin{cases} \frac{y^{1-\rho} - 1}{1 - \rho} & \rho \neq 1 \\ \log y & \rho = 1 \end{cases}$ where u is utility (proxied by SWB), y is income, and ρ is the elasticity of marginal utility with respect to income, and estimate $\rho = 1.26$.

³²A recent study of lottery wins also suggests that the SWB impacts of income are partly contingent on feelings of ‘deserving’ the money, so that it is not true that ‘a dollar is just a dollar’ (Winkelmann et al., 2011). This is consistent with work in psychology and philosophy — for example, Annas (2004, p. 50, italics in original) reports that a group of business ethics students “thought of a happy life as one in which they *earned* the money, *made* something of their lives so that these things [material wealth] were an appropriate reward for their effort, ambition, and achievement. Just having the stuff was not all they wanted”.

2.5.1.2 Past and relative income

Individuals' own past incomes are negatively associated with their current SWB. This habituation or adaptation effect is very substantial — several studies find that adaptation eliminates more than half of the positive effect of income gains over the long term (Clark et al., 2008b, p. 111) — and is not fully anticipated by individuals (Layard, 2005b).

The income of an individual's reference group has also been widely found to have a significantly negative effect on his or her SWB; in fact, reference group income may be substantially more important than own absolute income for individual happiness (e.g. Knight et al., 2009). It is generally assumed that this effect is caused by status concerns, sometimes described as rivalry or jealousy.

Social comparisons could also work in the opposite direction if the rising income of others were interpreted as a signal of one's own future income possibilities. Senik (2008a) identifies such an effect (described as the effect of information or ambition) in transitional eastern European economies and the US. Jealousy and ambition effects are not mutually exclusive. Their relative importance may depend on perceived income mobility and uncertainty — higher levels of either implying a stronger ambition effect (*ibid.*) — and on which of an individual's many potential reference groups is under consideration.

Most studies have defined the reference group as people who are similar on a specific set of characteristics (e.g. age, education, employment sector), using either cell averages (e.g. average income for individuals in the same age \times education \times employment sector category) or predicted incomes from a wage regression (Clark et al., 2008b). But reference groups can also be defined over a specific geographical area (e.g. Luttmer, 2005; Knight et al., 2009); as family members, friends, or work colleagues; or as explicitly reported by the SWB survey respondent (these approaches require more data, and have been less widely employed).

Implications Income habituation and (if individuals make social comparisons primarily within their own countries) rivalry both help to explain the Easterlin Paradox — that, although individuals' incomes in cross-sectional studies are positively related to their SWB, for many countries there appears to be no corresponding effect of rising GDP on average national happiness figures over time. They also suggest that economic growth is of rather less importance than economists have traditionally assumed (but this is a contested issue — e.g. Stevenson & Wolfers, 2008). Rivalry implies that visible consumption imposes a negative externality on others, while unanticipated habituation to income implies that people will choose to work more and take less leisure than would be rational for them. Both of these effects could inspire corrective taxation policies (Layard, 2005b; see also section 2.6).

2.5.2 Other factors

Except where other citations are given, the comprehensive review by Dolan et al. (2008) provides further detail on the factors identified here.

Personal and demographic characteristics Good psychological and physical health both have a strong, positive effect on SWB, in line with intuition. Almost all studies find a U-shaped relationship between age and SWB, with the young and old being happiest. Where a gender difference is detected, women usually report slightly higher happiness. In the US, whites have on average higher SWB than African Americans. The impact of education varies between studies: in some it has no significant effect, while in others highest SWB is variously associated with lower, higher, and intermediate levels of education. Marriage and stable partnerships are highly positive for SWB (though the potential for omitted variables bias is large here); separation, divorce and widowhood are highly negative. Parental divorce is found in some (but not all) studies to reduce children's SWB in adulthood. Evidence on the effect on parents of having children is rather mixed, depending on the SWB measure, country, number and age of children, and parental situation.

Work and time use Unemployment has one of the largest negative impacts on SWB, independent of and larger than the associated material loss, reducing reported happiness by 5–15% (where

scale cardinality is assumed). Evidence regarding the effects of different types and hours of employment is scarce and somewhat mixed. Commuting to work is associated with lower SWB levels, all other things being equal. Informal care-giving has a negative effect on SWB. Community involvement and volunteering may have a positive effect, but this finding is somewhat variable (depending on what is controlled for, and whether fixed effects are included). There is evidence, albeit somewhat limited, that physical activity promotes SWB. Finally, socialising and regularly attending church are both associated with higher SWB, while TV viewing goes with lower SWB (Bruni & Stanca, 2008).

Attitudes and beliefs Trust in 'most people', in the people in one's neighbourhood, and in institutions such as the police and government are all positive predictors of SWB (although great caution is required when regressing subjective variables on other subjective variables). Religious beliefs are generally associated with higher SWB too. Political views have not been widely studied, but may affect the impacts of other circumstances, including which party is in power (MacCulloch & Di Tella, 2005). Satisfaction in specific life domains tends to correlate positively with global SWB, and may partly or entirely mediate the effect of objective circumstances. SWB is also related to major personality traits such as extraversion and conscientiousness (Weiss et al., 2008).

Economic and political environment High unemployment rates may reduce SWB, although research is limited (high local unemployment rates may also ameliorate the impact of an individual's own unemployment, however). Inflation may also have a negative influence on SWB, especially for those with right wing politics. Democracy, and particularly direct or participative democratic systems, may be positive for SWB. Evidence on income inequality is very mixed; its effect may depend partly on real or perceived mobility. There is little evidence concerning the effects of social insurance and the welfare state.

Natural and immediate environment Living in an unsafe or deprived area is, unsurprisingly, detrimental to SWB. Living in public housing may be negative for SWB (Brereton et al., 2008), but other aspects of housing quality seem to be little studied. Living in large cities appears unfavourable, while rural living has a positive impact in SWB terms (at least once lower rural incomes are controlled for). The evidence of environmental quality effects is still limited, although several studies find a negative impact of air pollution on SWB. Some studies also find a link between climate and SWB, such that more extreme climates are detrimental. This research is examined in greater detail in subsection 3.2.3.

The variation in SWB explained by all observed factors is well below 50% in all studies, which may partly owe to an important (and unobservable) genetic component: one study of identical twins raised apart suggests that up to half of the variation in SWB could be genetically based (Tellegen et al., 1988, p. 240)³³.

2.6 What does this mean for public policy?

Happiness research has been a subject of substantial interest in the political and policy spheres. Following a 2007 conference hosted by the European Commission, European Parliament, Club of Rome, OECD and WWF, the OECD's *Measuring the Progress of Societies* and the European Commission's *Beyond GDP* projects aim to foster the development of non-GDP indicators, including happiness (Commission of the European Communities, 2009; <http://www.oecd.org/progress/>; <http://www.beyond-gdp.eu/>).

The French and German governments have commissioned recent reports on this topic (Stiglitz et al., 2009; Kroll & Meditz, 2009), with the French president subsequently instructing the national statistics agency to give greater weight to quality of life issues (Jolly, 2009). In Canada a network of governmental and non-governmental organisations is collaborating on a Canadian Index of Wellbeing (Institute of Wellbeing, 2009).

³³As with all heritability measures, however, this figure is as much dependent on the range of variation in material circumstances in one society at one time as it is on any genetic mechanism. For example, if all of a society's children were raised in absolutely identical circumstances, then the heritability of all traits — being the percentage of variation accounted for by genetic factors — would necessarily be 100%.

In the UK, happiness entered electoral politics in the speeches of, and Quality of Life policy commission set up by, the UK Conservative Party leader (Cameron, 2006; Watt, 2007). Its implications have been examined by a Strategy Unit report (Donovan et al., 2002), by Defra's Whitehall Well-being Working Group (Easton, 2006), by a Government Office for Science 'Foresight' project (Foresight Mental Capital and Wellbeing Project, 2008) and in various other departments (sustainable-development.gov.uk, 2007). The Treasury's *Green Book* has been updated with a brief discussion of the use of wellbeing data for project evaluation and appraisal, and the government recently announced that official "general wellbeing" indicators will in future be produced by the Office for National Statistics (Matheson, 2011).

Those championing SWB in policy have tended to argue as a first step for just this kind of systematic measurement: the creation of wellbeing indicators, standing alongside existing economic indicators, to assess performance at national and/or regional levels (e.g. Michaelson et al., 2009). Policy in an extremely wide range of areas has potential to affect individuals' SWB; not only areas with an obvious and direct connection, such as mental health services, but also taxation, (un)employment, environment, and many more. It could be argued, therefore, that SWB considerations should inform policy development in those areas; Veenhoven (2004), for example, writes that "the greatest happiness principle deserves a more prominent place in policy making". This 'new utilitarianism' is potentially subject to the same variety of critiques as the traditional brand, however.

At a philosophical level, Nozick (1974) finds a utilitarian system vulnerable to the so-called 'utility monster', who derives greater utility from the sacrifice of others than those others lose — such that total utility is increased by sacrificing everybody to the monster — and Parfit (1986) offers the 'repugnant conclusion' that a world of many people just barely surviving could have greater total utility than a world of fewer people with higher individual utilities. In practice, these objections are easily dismissed: the 'utility monster' does not exist, and both arguments rely on naïve interpretations of Bentham's 'greatest good for the greatest number' as a simple sum (or alternatively, in Nozick's case, average) of individual utilities.

But this point does raise an important question — what *should* be the social welfare function that aggregates individual utilities? — to which there is no clear answer. International SWB research often uses mean self-ratings, but this assumes cardinality and implies total agnosticism as to the distribution of happiness. A 'U-Index' is a further possibility (see [subsubsection 2.2.1.2](#)). So too is an (ordinal-only) Pareto-optimality principle; but this is no less problematic in relation to the allocation of wellbeing than it is in relation to other resources (Sen, 1978)³⁴.

Another class of objections to any role for SWB in the policy process concerns ethics and rights: unconstrained maximisation of a happiness indicator (or indeed any other indicator) could take societies in ethically questionable directions (Johns & Ormerod, 2007, p. 14). For example, Ng's arguments (1997, pp. 1849 – 1850) for the "widespread use" of "electrical, chemical and mechanical stimulation of... the pleasure centres in our brain" seems not so far removed from the widespread use in Huxley's *Brave New World* of the drug 'soma' to induce blissful contentment with caste-based roles (e.g. Veenhoven, 2004); whether this is vision is utopian or dystopian is open to debate. As another example, the risk that the rights of minorities could be violated under a utilitarian principle is raised — and alleged to have been realised in the form of ethnic cleansing in the Kingdom of Bhutan (Johns & Ormerod, 2007, p. 70).

In essence, the criticism here is that utilitarianism is a purely consequentialist ethical theory, concerned only with the outcomes of actions, and therefore fails to place off-limits actions which are widely held to be wrong. But this criticism is of a straw man. In practice, there is no reason why the consideration of likely happiness outcomes in relation to policy should be accompanied by the jettisoning of all ethical rules, including deontological ideas about what is inherently right or wrong. Maximising happiness is no more sinister than maximising income or any other quantity; it is only that the most relevant rule-based constraints on our means of doing so may not be the same for every maximand.

As noted in [subsection 2.4.5](#) in relation to development, adaptation is sometimes identified as a further problem: what if people in objectively bad situations are subjectively satisfied? Sen (1999, p. 19) notes that an emphasis on "*mental satisfaction*" (his italics) could be opposed to the

³⁴Of the Pareto-optimality principle, Sen (1978, p. 22) writes: "This may seem alright as far as it goes, but how far does it go? ... If preventing the burning of Rome would have made the emperor Nero feel worse off, then letting him burn Rome would have been Pareto optimal. In short, a society or an economy can be Pareto optimal and still be perfectly disgusting".

"creative discontent and constructive dissatisfaction" necessary to overcoming deprivation and oppression. More specifically, Deaton (2008, pp. 30 – 31) argues it is right that "self-reports of satisfaction with life, with income, or health are given little weight" in evaluating development progress. However, as also noted in that subsection, the problem of adaptation — which is neither universal nor indiscriminate — may have been exaggerated, and in practice does not seem so acute as to rule SWB out of policy consideration, especially in richer countries.

Finally, partisan political objections are made: generally, in relation to government interest in SWB; and specifically, in relation to supposed policy implications of some of the findings of SWB research. In the general case it is sometimes argued, along classic liberal lines, that making people happy is not a legitimate role of government, which should confine itself to the protection of property rights and prevention of harm: Thompson & Marks (2008) see this argument behind the association of government interest in wellbeing with 'paternalism' and the 'nanny state' in sections of the media³⁵. As to the specifics, commentators on the Right have taken against the suggested benefits of greater redistributive taxation (e.g. Wilkinson, 2007), for example, while the Left has baulked at findings of a positive association of SWB with stable family life, religious faith, or ethnic homogeneity³⁶ (Ormerod & Johns, 2007).

These partisan objections highlight what is perhaps the central issue. SWB is not a technocratic panacea: it "does not actually help us to solve the problem of divergent social values and policy objectives... and does not provide us with a set of recommendations that over-ride political antagonisms and public debate" (Duncan, 2008). In summary, it is not clear exactly what maximising aggregate social happiness means, and even if it were, this would not be sufficient as a guide to policy.

However, SWB research can inform our public discourse with valuable empirical data (*ibid.*). It opens to serious and hard-headed scrutiny whether there are sources of welfare beyond income and consumption, what those sources are, and what some of the trade-offs between them may be. It is therefore an especially valuable input into contemporary debates regarding the desirability and feasibility of perpetual economic growth (e.g. Jackson, 2009; Simms et al., 2010). Diener et al. (2009, Chapter 4) explore a variety of additional ways in which SWB research can contribute to policy development.

2.7 Where next for happiness economics?

Despite the recent surge in interest in the economics of happiness, it is still a relatively young area, with substantial scope for further research: either answering new questions, or providing better answers to existing questions. These could be questions about the impacts of different factors on individuals' SWB; questions about SWB itself; or questions which SWB can help to answer.

Questions about what affects SWB Many of the factors already identified as influential on SWB could benefit from further research, especially research using data collected for the purpose: the secondary data sets used in many analyses lack detail on some of the most important determinants of SWB. For example, there still appears to be scope for research into income and consumption effects on SWB — including measures of these relative to different reference groups — and into the extents of rivalry and habituation in respect of different kinds of consumption (and of other activities).

A focus on how different factors interact would also help in producing a more complete and nuanced picture of the factors affecting SWB. For example, how do age or education or political, religious or environmental views mediate the impacts of other variables and life events? Models here include Finkelstein et al. (2008), who examine the impact of health status on the marginal utility of income, and Clark et al. (2005), who estimate different SWB functions for different classes of individuals emerging from their data. In addition, studies might usefully deal more explicitly

³⁵They cite as examples columnists Minette Marrin — "The 'national happiness audit' would enable us to form and judge social policies... This is without a doubt the scariest idea I have read for many years" ('The dangerous business of happiness', The Sunday Times, 18 June 2006) — and Alexander Waugh — "... if any of these foppish utilitarian suggestions were put into practice, nothing short of national manic-depression would ensue" ('Enter the happiness police', The Daily Telegraph, 13 March 2005).

³⁶See Layard (2003) on the work of Glaeser & DiPasquale (1999) and Sampson et al. (1997) on ethnic homogeneity.

with factors among which there is substantial multicollinearity, such as income, education, and health.

Questions about SWB itself As regards SWB itself, the temporal dimension has been relatively little studied in the economic literature to date, but is important for the interpretation and use of SWB data. Greater use of ESM/EMA and DRM could help in developing a better understanding of how SWB varies hour by hour or day by day. For example, individuals are commonly asked for SWB evaluations in the ill-defined general present ('nowadays', 'these days', etc.). What is the effect of past SWB (and past factors which affected it) on such evaluations? And, perhaps more challengingly, what is the influence of expectations regarding future SWB and future causal factors (income, marital status, environmental quality and so on)? [Van Praag & Ferrer-i-Carbonell \(2008, ch. 7\)](#) and [Senik \(2008b\)](#) provide a first glimpse at these issues. These methods could also provide rich and credible data sets for use in various other kinds of analyses, such as examining the effects of different health states on wellbeing ([Dolan & Kahneman, 2008](#)), or linking wellbeing measures to choice behaviour ([Smith, 2008](#)).

The spatial dimension of SWB also appears somewhat neglected. Spatial techniques used in other disciplines and other areas of economics (such as hedonic pricing studies) might valuably be applied to SWB data — to date, only [Stanca \(2010\)](#) and [Rehdanz \(2007\)](#) report the use of such methods. The social dimension of SWB is also a promising area, potentially using the same spatial methods (since proximity in social network terms can provide alternative conceptions of space, distance and neighbourhood). [Fowler & Christakis \(2008\)](#) and [Christakis & Fowler \(2009\)](#) appear to provide the only published research on this topic so far (and are not working within economics); they relate SWB to social proximity as measured in a long-term longitudinal medical study and using the social networking site Facebook.

Other areas that might be fertile ground for new economic research into SWB include the use of anchoring vignettes — to try to correct for variation in reporting functions, as attempted by [Angelini et al. \(2008\)](#) — and of evolutionary or sociobiological reasoning — to provide a theoretical grounding for hypotheses and interpretations regarding the factors that influence SWB, as begun by [Rayo & Becker \(2007a; 2007b\)](#).

Questions that SWB can help answer Two additional kinds of economic questions could benefit from further application of the SWB approach. First, as noted in [subsection 2.4.3](#), SWB data provides a new and potentially powerful method for non-market valuation. And second, it could permit research into the utility impacts of differing choice sets (if it is allowed that factors such as self-control may mean that more choice is not always preferable), which is simply not possible using revealed preference data (see [Koszegi & Rabin, 2008](#)).

2.8 Summary and conclusions

The economics of happiness or SWB is a relatively new field within the discipline (albeit one with clear antecedents), and it continues to expand and mature. Having arisen at the edges of several other research areas, increasingly it has a momentum of its own.

While there can be no formal proof that one person's happiness is comparable to another's, a large body of evidence now indicates that such an assumption can be both reasonable and useful. Meanwhile, the application of increasingly sophisticated econometrics has ensured that the additional assumptions required for the analysis of SWB data become progressively less restrictive. The assumptions implicit in some empirical work, especially with cross-sectional and cross-cultural data, can still be problematic, however.

SWB research suggests — in line with intuition, but not always with the emphasis of recent economic literature — that absolute income is only one of a wide range of factors with important implications for human welfare. SWB approaches can complement existing approaches to certain economic questions, such as non-market valuation, where both their strengths and their weaknesses are different. It also opens some new question to potential investigation. In respect of public policy, it is of particular value in informing debate around the desirability and feasibility of continuing economic growth.

Scope remains for new research at many levels — theoretical, methodological, and empirical — in the economics of SWB. Temporal, spatial and social dimensions seem especially ripe for future investigation. In both strands of the research presented in this thesis, we investigate environmental associations with wellbeing using spatial methods. In the second, we adapt ESM techniques to provide information about wellbeing both across space and through time.

Chapter 3

Happiness and environmental quality

Having surveyed the literature on subjective happiness within economics, in this short chapter we look somewhat beyond the discipline in search of answers to two additional questions. Why might we expect links between happiness and environmental quality (EQ)? And what evidence is there that such links exist?

3.1 Why might happiness and EQ be linked?

In this thesis we define EQ broadly as the presence of environmental goods — such as natural landscapes, scenic views, preferred climates, or biodiversity — and the absence of environmental ‘bads’, such as air pollution or noise. There are at least four broad reasons for hypothesising that EQ might be positively related to SWB (with different reasons being more or less applicable to particular EQ characteristics).

3.1.1 Habitats, psychology & evolution

Hypotheses regarding the landscapes or habitats considered to be environmental goods — for example, what is it that makes a scenic view scenic? — are generally of a (proximately) psychological and (ultimately) evolutionary kind. Such hypotheses, of which Hartig et al. (2010) provide a survey, try to explain how selective pressures have shaped the human mind so that is attracted to particular habitats or habitat characteristics. Although evolutionary hypotheses are rarely testable, they can provide helpful starting points for empirical research.

Several authors have posited an innate human emotional affiliation to nature and other living organisms in general, for which Wilson (1993) popularised the term *biophilia*. This affiliation is proposed as an adaptation to our reliance on the natural environment throughout all but the past 10,000 years of our history. Affinities with more specific habitats, including savanna and forest, have similarly been postulated on the basis that these habitats would have provided our hominin ancestors with the greatest reproductive success (Orians, 1980; Falk & Balling, 2010; Han, 2007).

Preferences for certain characteristics of natural habitats have also been conjectured: for example, the availability of locations from which one may see but not be seen, enabling one to attain goals while evading hazards ('Prospect-Refuge' theory), or the ease with which spatial information can be acquired and processed, facilitating understanding and exploration of the environment (the 'mystery/complexity/legibility/coherence' model) (Appleton, 1975; Kaplan & Kaplan, 1989; Stamps, 2004; Hartig et al., 2010). Yet more abstractly, preferences have been suggested over shapes or patterns characteristic of natural scenes, such as specific fractal dimensions, energy levels at certain spatial frequencies, or ratios of colour contrast to luminance contrast (Aks & Sprott, 1996; Juricevic et al., 2010).

Of course, positive effects of natural environments could be recast as an absence of the negative effects of non-natural, urban environments. Urban environments may have negative impacts

Table 3.1: Health effects of air pollution

<i>Effects attributed to short-term exposure</i>
Respiratory and cardiovascular hospital admissions
Respiratory and cardiovascular emergency department visits
Respiratory and cardiovascular primary care visits
Use of respiratory and cardiovascular medications
Days of restricted activity
Work absenteeism
School absenteeism
Acute symptoms (wheezing, coughing, phlegm production, respiratory infections)
Physiological changes (e.g. lung function)
<i>Effects attributed to long-term exposure</i>
Mortality due to cardiovascular and respiratory disease
Chronic respiratory disease incidence and prevalence (e.g. asthma)
Chronic changes in physiologic functions
Lung cancer
Chronic cardiovascular disease
Intrauterine growth restriction

Source: World Health Organisation (2000) in Gouveia & Maisonet (2005)

owing to the high levels of arousal, stress, or directed attention they engender or require (Ulrich et al., 1991). According to Kaplan's (1995) 'Attention Restoration Theory' and Ulrich's broader 'psycho-evolutionary theory' (Ulrich et al., 1991) the lack of these factors in natural environments — as well as the presence of certain other characteristics — permits stress recovery and the restoration of attentional capacity.

3.1.2 Environmental 'bads', physical & mental health

Urban environments may also have a detrimental effect because of higher levels of certain environmental 'bads', which in turn could affect happiness via significant and direct impacts on physical and/or mental health.

Adverse health effects of noise and air pollution are well documented. Chronic traffic noise exposure in urban environments can cause severe sleep disturbance, hearing impairment, tinnitus, and raised stress levels, leading to high blood pressure, coronary heart disease, stroke, and possibly immune system and birth defects (Passchier-Vermeer & Passchier, 2000). The various adverse health effects of air pollution are summarised in Table 3.1. Certain groups are particularly susceptible to air pollution, including those with respiratory or cardiac diseases or asthma, infants, children and the elderly, and those with low socio-economic status (SES), low levels of education, poor nutrition and poor general health (Utell et al., 2005).

As noted by Welsch (2006), this link does not require that individuals are conscious of the causal relationship between an environmental problem and their own happiness. However, awareness of a local environmental problem, and of its negative effects on human and ecosystem health, could also act to reduce happiness levels directly and independently. There is evidence that individuals' perceptions of air pollution are positively correlated with objective pollution measures (Day, 2007). Individuals are generally aware of the sources of pollution (principally, main roads), of its fluctuation according to weather conditions, and of the negative health effects with which it is associated, especially for children (Bickerstaff & Walker, 2001). This makes individuals' perceptions of air pollution an additional route by which the pollution may influence their happiness.

3.1.3 Associated benefits of natural environments

Natural environments might increase happiness by facilitating and encouraging — for practical, cultural and/or psychological reasons — behaviours that are physically and mentally beneficial, including physical exercise, recreation and social interaction (e.g. [Barton & Pretty, 2010a](#); [Morris, 2003](#)).

3.1.4 Household production function

Finally, EQ characteristics may enter the household production function ([Becker, 1965](#)), altering the costs of producing commodities or service flows of value to the household. For example: aspects of climate such as temperature and precipitation may alter the costs of achieving a given level of comfort, via expenditures on heating and cooling, clothing and nutrition ([Maddison, 2003](#); [Maddison & Rehdanz, 2010](#)); and, since absence of noise may be regarded as an input in the production of sleep ([van Raaij, 1981](#))¹, noise could raise the household's costs through defensive expenditures on double glazing, ear plugs or sleeping pills.

3.2 What evidence of such a link exists?

Researchers in urban planning, epidemiology and psychology have pursued observational and experimental evidence on links between physical or mental wellbeing and EQ. Economists have sought observational evidence of links between happiness and EQ, generally using these to derive monetary valuations of EQ characteristics.

3.2.1 Studies outside economics

Observational studies have compared individuals' health and wellbeing reports or medical records with the proximity of their homes to natural environments, or with alternative indicators of local environmental quality (e.g. [Kaplan, 2001](#); [Takano et al., 2002](#); [de Vries et al., 2003](#); [Grahn & Stigsdotter, 2003](#); [Maas et al., 2006](#); [Nielsen & Hansen, 2007](#); [Björk et al., 2008](#); [Maas et al., 2009](#)). On occasion they have also related averaged wellbeing measures to aggregate environmental characteristics between geographical regions (e.g. [Mitchell & Popham, 2007](#)).

Experimental and quasi-experimental studies have investigated physiological and psychological effects of exposure to images of different environment types (e.g. [Berto, 2005](#); [White et al., 2010](#); [Ryan et al., 2010](#)) or to short-term interventions bringing subjects into contact with nature (e.g. [Hartig et al., 2003](#); [Pretty et al., 2007](#); [Berman et al., 2008](#); [Barton & Pretty, 2010b](#); [Ryan et al., 2010](#); [Martens et al., 2011](#)). They have also related health and wellbeing indicators to views of nature in settings where individuals' accommodation is assigned exogenously: public housing ([Kuo & Sullivan, 2001](#)), prisons ([Moore, 1981](#)), and hospitals ([Ulrich's much-cited 1984 paper in Science, 'View through a window may influence recovery from surgery'](#)).

Though all of these studies report beneficial impacts of natural environments on health or wellbeing, they have some common weaknesses. Observational studies measure domestic proximity to natural environments but rarely look at actual experiences of such environments (which may or may not occur around the home, and may occur elsewhere); cannot provide data on the moment-by-moment hedonic or affective element of wellbeing; and are reliant on retrospective assessments that are subject to substantial recall bias ([Robinson & Clore, 2002](#)). Experimental studies are stronger in these respects but — with the possible exception of [Kuo & Sullivan's](#) — are generally low in ecological validity: by their nature they tell us a limited amount about peoples' real experiences of natural environments in their everyday lives.

3.2.2 Studies in conventional economics

As noted in [subsubsection 2.2.3.2](#), relationships between location and quality of life have long been a subject of interest in the hedonic pricing literature in economics, in which environmental

¹Alongside a house, a bed, and time ([Becker, 1965](#), p. 495).

and urban amenities have been used to account for regional wage and rent differentials and construct 'objective' quality of life indices (Roback, 1982). Hedonic valuation has been used to investigate the impacts of various dimensions of EQ, including: road, rail and aircraft noise (e.g. Tomkins et al., 1998; Wilhelmsson, 2000; Espy & Lopez, 2002; Day et al., 2007; Andersson et al., 2010); climate (e.g. Englin, 1996; Maddison & Bigano, 2003; Rehdanz & Maddison, 2009); air quality (e.g. Ridker & Henning, 1967; Harrison Jr. & Rubinfeld, 1978; Kim et al., 2003; Chay & Greenstone, 2005; Bayer et al., 2009 — or the 37 studies reviewed by Smith & Huang, 1995); water quality (e.g. Boyle et al., 1999; Poor et al., 2007; Leggett & Bockstael, 2000); waste sites and other contaminated land (e.g. Hite et al., 2001; Brasington & Hite, 2005; Neupane & Gustavson, 2008); urban trees (e.g. Morales, 1980; Thorsnes, 2002; Netusil et al., 2010; Sander et al., 2010; Donovan & Butry, 2010); and land cover, including forests, parks and green spaces, coasts, wetlands, rivers and open water (e.g. Correll et al., 1978; Garrod & Willis, 1992; Powe et al., 1995; Doss & Taff, 1996; Powe et al., 1997; Luttik, 2000; Mahan et al., 2000; Tyrväinen & Miettinen, 2000; Earnhart, 2001; Paterson & Boyle, 2002; Morancho, 2003; Kong et al., 2007; Payton et al., 2008; Cavailhès et al., 2009; Smith, 2010; Gibbons et al., 2011).

Studies vary in scale: they may cover part or all of a neighbourhood, city, region or country. Many studies focus on a single environmental (dis-)amenity, but some cover a broader range (e.g. Powe et al., 1995; Cavailhès et al., 2009). Land use and land cover characteristics have been measured most commonly in terms of adjacency or distance-to-nearest (e.g. Correll et al., 1978; Thorsnes, 2002), but studies increasingly calculate the proportion of cover within an administrative area, grid cell or radius (e.g. Garrod & Willis, 1992; Netusil et al., 2010; Gibbons et al., 2011), or define indices in relation to viewsheds or visibility (e.g. Paterson & Boyle, 2002; Cavailhès et al., 2009).

Studies vary widely in terms of the range of spatial control variables included in the hedonic regressions. These variations may be explained in part by scale (e.g. climate variation is unlikely to be relevant across a single neighbourhood), by socio-cultural factors (e.g. '% (non-)white' variables are common only in US studies), and by the availability of data sets and of the GIS technology to analyse them. In general, studies include a limited selection from the following controls:

accessibility and distance measures such as to city centres, industrial or commercial zones, shopping or employment centres, roads, motorways, railways, stations, airports, hospitals, schools, universities, swimming pools, post offices or churches;

demographic and social class indicators across local areas, including housing stock type, age, ownership and quality, occupation or education profile, unemployment rate, income and benefits, age profile and family composition, car ownership, commuting and commuting time, or dummies for wards or geodemographic segmentation classes (such as MOSAIC or ACORN classifications in the UK);

taxes and services, including local tax rates, per capita government expenditure, arts and cultural facilities, doctors or hospital beds per capita, and school quality indices (such as raw or 'value added' test scores, pupil-teacher ratios, or truancy rates); and

other quality of life and area characteristics such as population density, crime and traffic accident rates, and the density of listed buildings.

3.2.3 Studies in happiness economics

As noted in subsection 2.4.3, environmental economists have more recently begun to use SWB data to quantify the impacts of EQ characteristics — either directly, in terms of their effects on SWB, or in monetary terms. Welsch & Kühling (2009, p. 398) give a synopsis of selected studies valuing EQ through SWB.

Air quality Welsch (2002; 2003; 2006; 2007), examining average SWB in relation to average (objective) air pollution values at country level, finds significant negative associations in each case. Menz & Welsch (2010), using data across 25 countries, find that higher PM10 concentrations are associated with reduced SWB and that the magnitude of this effect is — like the health impairments associated with air pollution — U-shaped in age. Rehdanz & Maddison (2008) find that *perceived* levels of air pollution are negatively related to SWB scores in Germany. Ferreira

& Moro (2010), working with individual-level data on air pollution and other EQ parameters in Ireland, also find negative associations between air pollution and SWB, as do MacKerron & Mourato (2009), using high-resolution air pollution data for London, Levinson (2009), who makes use of temporal variations in air pollution levels in US counties, and Luechinger (2009), who uses the installation of scrubbers at a power plant in Germany as a natural experiment.

Climate Frijters & Praag (1998) find that individual-level SWB in Russia is positively associated with hours of sunshine, days of rain, and interactions of average temperature with precipitation and temperature with windspeed in January, and negatively related to quantity of rainfall, January windspeed, and interactions of average humidity with temperature and rural location with precipitation. Rehdanz & Maddison (2005), looking at climate variables at country level across 67 countries, find that higher mean SWB is associated with higher mean temperature during cold months and lower mean temperature during hot months. Maddison & Rehdanz (2010), using data from 87 countries, conclude that deviations from an ideal temperature of 18.3°C significantly reduce life satisfaction. Moro et al. (2008) find higher individual SWB in Ireland to be related positively to annual hours of sunshine and millimetres of rainfall, and negatively to wind speeds. Using the same data Ferreira & Moro (2010) find a positive association in Ireland between SWB and average temperatures in both January and June².

Noise Van Praag & Baarsma (2005), investigating aircraft noise around Amsterdam Schiphol airport, find that individuals' experienced noise nuisance is negatively related to SWB, although direct noise measures are not significant. Weinhold (2008) finds *perceived* noise pollution levels a strongly negative predictor of SWB in individual-level data across Europe.

Waste sites Brereton et al. (2008) find that very close residential proximity to landfill sites (being within the same electoral district) has a negative SWB association, and Moro et al. (2008) reach the same conclusion regarding the per capita number of landfill sites by local authority area. Ferreira & Moro (2010) do not find a significant effect of landfill sites within 5km, and Brereton et al. (2008) detect no impact of proximity to hazardous waste facilities, however.

Water quality Israel & Levinson (2003) report that individuals' life satisfaction is negatively associated with country-level per capita emissions of organic water pollutants. Ferreira & Moro (2010) detect no significant effect of being situated within 5km of a 'severely polluted' river.

Coastline Brereton et al. (2008) and Moro et al. (2008) find that close proximity to coastline (within 2km or in the same local authority area respectively) has a positive association with SWB, but Ferreira & Moro (2010) find no significant effect of coastline within 5km.

Biodiversity Rehdanz (2007) runs spatial regression models with country-level data on simple counts of bird and mammal species, and the proportions of species that are threatened, and suggests that greater numbers of species, and lower proportions of bird species threatened, are associated with higher SWB.

Natural capital Vemuri & Costanza (2006) and Engelbrecht (2009) report positive relationships between indicators of wellbeing and generalised 'natural capital' at country level. Vemuri & Costanza measure natural capital as the 'ecosystem services product' based on land cover types (Sutton & Costanza, 2002), which can arguably be considered EQ-related. Engelbrecht's natural capital figures do not appear to be appropriate EQ measures, however, since reserves of resources such as metal ores, oil and coal feature heavily.

²Moro et al. (2008) do not find a significant temperature effect, but Ferreira & Moro (2010) include fewer other climate characteristics in their model, so the difference in findings might be a result of omitted variables or of multicollinearity in the explanatory variables.

3.2.3.1 Limitations

Country-level studies Several studies compare mean SWB and mean EQ values at the whole-country level (all Welsch's air pollution papers cited above; Israel & Levinson, 2003; Rehdanz & Maddison, 2005; Rehdanz, 2007; Vemuri & Costanza, 2006; Engelbrecht, 2009; Menz & Welsch, 2010)³. Although this has the advantage that unobserved heterogeneity across individuals is evened out, it means that SWB and EQ levels are assessed only on an extremely aggregated scale — with no indication of variability or of actual EQ exposures — and that other sources of heterogeneity across countries, including linguistic and cultural heterogeneity, then need to be controlled for⁴. It also requires a cardinal interpretation of SWB responses (though in practice, as discussed in subsubsection 2.2.2.1, this tends not to be problematic).

Individual-level studies The remaining papers use individual-level SWB data, controlling for various demographic, socio-economic and attitudinal variables in addition to indicators of EQ near respondents' homes.

A major limitation of most of these studies remains the level of spatial aggregation of EQ measures, which are rarely at better (and frequently at worse) than electoral ward level. The use of such spatially aggregated statistics leads to reduced accuracy, to an extent which may be problematic in the case of characteristics varying over short distances, such as noise or air pollution⁵. It also raises the Modifiable Areal Unit Problem (MAUP): it could be that substantially different results would have been obtained if measurements had been aggregated across different spatial units (e.g. Openshaw, 1984).

Even where EQ near the home is estimated accurately, that quantity may itself not correspond closely to an individual's actual exposure to or experience of EQ. For example, exposure in or near the home to certain kinds of air pollution may account for only a small fraction of the total variation in exposure (Huang & Batterman, 2000).

Studies have commonly focused on only a single EQ parameter (e.g. noise), despite probable correlations of that parameter with other EQ and broader spatial characteristics (e.g. air pollution, land cover type, transport amenities)⁶. This omission of a broader range of spatial variables in general seems liable to lead to endogeneity. Furthermore, since EQ differentials may be compensated by wages and house prices, differing approaches regarding the inclusion of income and house price data mean that different studies turn out to be measuring different things (see subsection 2.2.3).

None of the studies addresses the potential influence on SWB of green space, such as grassland or forest, despite the evidence from other disciplines (and hedonic pricing studies) that green space has a positive wellbeing effect. Few have considered 'blue space' — coastal or freshwater environments — while those that have (Brereton et al., 2008; Moro et al., 2008; Ferreira & Moro, 2010) include only distance to the coast.

Apart from Engelbrecht's, none of the studies investigate the sensitivity of their results to the use of alternative SWB items, and none make use of potentially more robust multiple-item SWB scales. Perhaps surprisingly given the spatial nature of the data, only one study (Rehdanz, 2007) turns to spatial econometric models, as have recently been used in hedonic pricing studies (e.g. Kim & Goldsmith, 2008; Anselin & Lozano-Gracia, 2008). Such models could help address problems of omitted spatial covariates (in the case of spatial error models) and inefficiencies in non-spatial estimators (for spatial lag models)⁷. Finally, only one study (Luechinger, 2009) offers a convincing strategy for the identification of causal effects.

³Israel & Levinson use SWB data at individual level but pollution data at whole-country level (and include only per capita GDP to control for any other differences between countries that might be correlated with pollution emissions).

⁴For example, Welsch (2002; 2007) purports to control for heterogeneity between 54 countries using only per capita income, 'rationality' (the number of scientists and engineers per thousand people) and — in the 2002 but not the 2007 paper — 'freedom' (as assessed on a 1–7 scale by an American NGO). Welsch's 2003 and 2006 papers use panel data with country and period dummy variables to better address unobserved international heterogeneity.

⁵Ferreira & Moro (2010) use relatively disaggregated measures, mainly calculated per electoral district (area: 18 to 6,189 hectares). However, their indicators of air pollution, which may vary over very short distances, are calculated by proximity to one or more of only 12 monitoring stations for the whole of Ireland. MacKerron & Mourato (2009) use exceptionally high resolution air pollution data (20m cells), but this study is weakened by the probable existence of omitted spatial covariates and by its reliance for SWB measures on a small convenience sample.

⁶The studies using Irish data by Brereton et al. (2008), Moro et al. (2008) and Ferreira & Moro (2010) are exceptions here.

⁷The usefulness of these spatial models has been questioned by some researchers, however (Gibbons & Overman, 2010).

No experience-level studies As noted in [subsubsection 2.2.1.2](#), longitudinal study designs in which participants provide ongoing reports of their everyday experience — Ecological Momentary Assessment (EMA) ([Shiffman et al., 2008](#)), the Experience Sampling Method (ESM) ([Hektner et al., 2007](#)), and the Day Reconstruction Method (DRM) ([Kahneman et al., 2004b](#)) — provide some of the best, most ecologically valid evidence regarding influences on wellbeing in general. None of the studies cited in this section ([3.2](#)) — nor any studies of EQ in any discipline, as far as we are aware — draw on data on the moment-by-moment hedonic or affective element of wellbeing collected in this way.

3.3 Summary and conclusions

In sum, there are good reasons to hypothesise that EQ levels will be positively related to SWB, and the existing evidence from a variety of experimental and observational sources — in happiness economics, other economic studies, and beyond — appears to point in this direction. We have identified a number of limitations of the existing evidence, focusing particularly on work in economics on happiness and EQ. In this thesis we attempt to rectify several, but not all, of these.

As discussed in [section 1.2](#), we conduct two strands of new empirical research. One makes significant but evolutionary improvements to the earlier work modelling retrospective happiness evaluations as a function of EQ in the local area, using cross-sectional, individual-level data. These improvements were detailed in [subsection 1.2.1](#). The other takes a somewhat more pioneering direction, investigating momentary happiness reports as a function of EQ in their immediate surroundings, using experience sampling techniques augmented with objective spatial measures, as explained in [subsection 1.2.2](#).

The following three chapters set out the methods employed in this connection. They cover our survey and ESM data collection methods, and describe the spatial and econometric analyses subsequently applied.

Chapter 4

Survey methods

In this chapter we describe the collection of new primary data to inform our analysis of retrospective happiness and local-area EQ.

To address our research questions we require valid and precise location data for respondents' homes and workplaces, which can later be joined with appropriate spatial data; responses to standardised life satisfaction, affect, and general wellbeing items and scales, free as far as possible of context effects; and major relevant control variables used in previous happiness research. No existing data sets are known that could provide this information.

Our claim is to improve on existing research, and this cannot be achieved with poor quality data. To demonstrate that appropriate care was taken to collect data of a high quality, we provide a reasonably detailed account of our methods here.

4.1 Web surveys

Two web surveys were conducted: one in Greater London and the other across the UK (including London). The London survey had a target sample of 1,000, and was in the field in August and early September 2009. The UK survey had a target sample of 2,000 and was in the field in late August and September 2010.

4.1.1 Survey mode characteristics

The web survey mode was selected in preference to alternative modes (mail, telephone, face-to-face or hybrid) principally for its speed, cost, and researcher time advantages,¹ and for its unique dynamic and interactive capabilities. Like all survey modes, web surveying has specific strengths and limitations, which are discussed further below; the balance of these strengths and limitations was felt to be acceptable for this research.

Web surveys are self-completed. Self-completed surveys must be unambiguous, complete, and absolutely clear about what is required, since there is no interviewer to deliver questions or assist the respondent. The absence of interviewers may permit a more consistent experience of the survey instrument across respondents (as long as certain technical issues are handled correctly) — on the other hand, since self-completion affords the respondent free choice of when and where to complete, it may reduce the consistency of the completion environment. The absence of any interviewer may reduce social desirability bias under certain simple conditions (Richman et al., 1999), which could be a significant advantage for life satisfaction and other psychological/social survey items. Self-completion does impose a literacy requirement, however, which is a source of selection bias.

Unlike other self-completion modes, web surveys allow full control over what is displayed to the respondent at all times, real-time checking of response completeness and validity, and

¹Cost and researcher time advantages are contingent on a range of factors, including the population to be surveyed and the desired sample size (Schonlau et al., 2002, xiv), and are much debated in the literature. These advantages were judged to be significant in the present case, especially given the researcher's prior experience and expertise in web development.

automatic, error-free transcription of responses. Web surveying also makes available some dynamic and interactive capabilities. In this study, dynamic routing (based on previous responses), randomisation (of question order and content), and the use of interactive question types were all extremely useful to the data-gathering process, and are described further in section 4.2.

4.1.2 Sampling

The population of interest in this research is defined as all residents of Greater London (comprising the 32 London boroughs and City of London) — or of the UK — aged 16 and above. Wellbeing amongst children and young adolescents is out of scope here for both theoretical and practical reasons².

To make valid statistical inferences concerning this population, each member of the population should have an equal chance of representation amongst our survey respondents or, at least, a known and non-zero probability of representation for use in weighting the data. This requires each to have: (1) an equal (or known) probability of inclusion within a sampling frame; (2) an equal (or known) probability of selection from the frame; and (3) an equal (or known) probability of response if selected. In practice, requirements (1) and (3) cannot be fully met by any sampling method: all methods are subject to some degree of selection bias.

4.1.2.1 Web user population

For a web survey, the most comprehensive sampling frame possible in theory would consist of all members of the population of interest with access to the web. However, since web access is not distributed at random amongst the population, this frame in itself would be a source of selection bias.

Across the UK in early 2009, 70% of households had an Internet connection (of which 96% had broadband), and 70% of individuals aged 14 or over reported having regular Internet access — at home, work, or college, for example (Dutton et al., 2009). Earlier figures suggest Internet access is somewhat more pervasive in London: in 2003–06, 58% of London households had access, against a UK average of 53% (Office for National Statistics, 2007a). Internet users do differ measurably from non- and ex-users, as illustrated in Tables 4.1 and 4.2. Table 4.2 highlights differences that might be expected to correlate with self-reported wellbeing³.

4.1.2.2 Web user recruitment

In practice, there is no comprehensive register of Internet users, and hence no obvious sampling frame. Web respondent recruitment options include mode switching (making initial contact by another mode — for example by phone, using Random Digit Dialling, or by post, using the Postcode Address File); pop-up advertising on web sites; use of a pre-recruited respondent panel; and convenience methods (Couper, 2000).

The best feasible method for this study was judged to be use of a pre-recruited panel. This does not provide a true probability sample, but does permit quotas to be set on a range of attributes. For this study the panel provider Toluna was selected based on personal recommendations from market research professionals⁴. Methods of pre-recruitment by panel providers are generally specified only in very broad terms for reasons of commercial confidentiality⁵.

²Many of the most important external correlates of adults' life satisfaction (such as employment and marital status) are not relevant to children, whose cognitive abilities may also preclude the use of scales developed for adults (Chaplin, 2009, p. 542). In addition, research with children presents more challenging requirements for ethical approval.

³The comparative data in Dutton et al. (2009) are based on face-to-face surveying by ICM — using a multi-stage, regionally stratified sampling design, with a sample size of 2,013 and response rate of 62% — weighted to a UK demographic profile. These data will themselves inevitably be subject to some degree of selection bias. For example, it seems at least plausible that those who agree to take part in face-to-face surveys will be on average both more trusting and more lonely than those that do not.

⁴Rob Sheldon (Managing Director of Accent MR) and Bill Blyth (European Research Director of TNS Europe).

⁵Toluna explains its panel recruitment as follows: "The use of social media within our online communities means that we are able to attract vast numbers of individuals who would not normally be a member of an online panel... the ability for a consumer to create their own polls and debates, public profiles and interact with other members, generates huge volumes of web traffic and subsequent registrations... We see a great deal of word of mouth and referrals from existing

Table 4.1: Internet use by selected demographic characteristics (source: Dutton et al., 2009)

% with Internet access	
<i>By education</i>	
Basic education	49
Further education	83
Higher education	93
<i>By social grade</i>	
AB	88
C1C2	77
DE	46
<i>By disability</i>	
No disability	75
Disabled	41
<i>By age</i>	
< 18	92
18 – 24	81
25 – 34	86
35 – 44	84
45 – 54	76
55 – 64	54
65 – 74	40
75+	20

Table 4.2: Selected statistics on Internet users and non-users (source: Dutton et al., 2009)

	Internet users	Non- and ex-users
<i>Time use</i>		
Time spent watching TV (mean hours per week)	15	25
Time spent meeting and socialising with friends and family outside the household (mean hours per week)	8	10
<i>Social and personal attitudes</i>		
Time feeling isolated from others (% responding 'some of the time' or more)	12	28
Trust in 'most people' (mean of 5-point scale: 1 = no trust at all, 5 = total trust)	2.8	2.5
"Sometimes I feel that I don't have enough control over the direction my life is taking" (% agreeing)	24	31

Panel members who are surveyed extensively might change their attitudes and/or response behaviour over time. This phenomenon is known as 'panel conditioning' (Clinton, 2001). Panel conditioning effects may be problematic: for example, panel members might learn to choose responses likely to minimise follow-up questions. But they may also be positive: panel members might get better at giving responses closer to their 'true values' (Göritz, 2007), or become accustomed to providing useful but potentially sensitive data, such as income or home postcode.

Panel members, who are offered incentives, might also attempt fraudulent survey completions, for example by completing the same survey on multiple occasions (under ostensibly different panel memberships), by falsifying information in order to be counted within a survey's scope, or by rapidly selecting answers without reading the questions. Panel companies employ a variety of means to counter such attempts (Norman, 2009), and a number of additional checks were performed for this study (see section 4.6).

4.1.2.3 Quotas

Since the pre-recruited panel is not a probability sample of the population of interest, and also includes individuals outside that population, sampling quotas were imposed. These quotas ensured that respondents fell within the desired population and were approximately representative of that population according to specific demographic characteristics (representativeness across other characteristics cannot be assured by this method, of course).

Quota cell sizes, and other detailed response statistics, are reproduced for both surveys in section A.1.

London Quota calculations were based on data from the quarterly Labour Force Survey (LFS), January – March 2009, waves 1 and 5 (which include earnings data), using the accompanying sampling weights, which are intended to reflect 2007 population figures (Office for National Statistics, 2008). The unweighted sample size for Greater London in this data set was 3,014. The LFS data covers individuals in NHS accommodation and private households (the definition of which is widened to count students in halls of residence as resident in the parental household) but not those in other communal establishments, and thus excludes approximately 1.5% of the population across Great Britain (Office for National Statistics, 2007b). The LFS was nevertheless believed to be the best and most recent available data set covering the characteristics of interest, including income and economic activity.

The quota parameters selected were location (inner London, outer London)⁶, gender (male, female), age (16 – 34, 35 – 54, 55+), and income and work status (employee below median earnings, employee on median earnings or above, other economic status), giving 36 interacted quota cells. Finer-grained categories for location, age, income and work status would have been preferable, but would have entailed an excessive number of interacted cells for the intended sample size ($N = 1,000$) and — in the case of location, income and work status — were not supported by the data available. Potential respondents who were unsure of or unwilling to disclose any of the quota information were routed out of the survey, since they could not be accommodated within any quota cell. This represents an additional source of selection bias.

UK Quota calculations were based on data from the Annual Population Survey, January – December 2009, and the accompanying sampling weights, intended to reflect 2009 population figures. The unweighted sample size of the data set was 333,430. The Annual Population Survey data is based on LFS data and on additional data from a sample boost in urban areas.

The chosen quota parameters were: location — within one of five large areas of roughly equal population⁷ — gender (male, female), age (16 – 34, 35 – 54, 55+), and work status (employee, other

members also. This means our panels are not overly biased towards individuals who are pre disposed to join a panel in exchange for a monetary reward... We also use a variety of media sources utilising a broad array of techniques that attract unique and responsive members such as banners, e-mails, keywords, text links, referrals, using a variety of ad messages and a broad range of partners." (Toluna, nd)

⁶Location was defined according to Government Office regions. Inner London is Camden, the City of London, Hackney, Hammersmith and Fulham, Haringey, Islington, Kensington and Chelsea, Lambeth, Lewisham, Newham, Southwark, Tower Hamlets, Wandsworth, and Westminster. Outer London is the remaining 19 boroughs.

⁷The five areas, each composed of one or more Government Office regions, were: (1) North East, North West, and Yorkshire and the Humber; (2) East Midlands, West Midlands, and East of England; (3) London; (4) South East and South West; and (5) Scotland, Wales and Northern Ireland. Respondents were assigned to areas by home postcode.

Table 4.3: Survey item sources

British Crime Survey 2006/07
British Household Panel Survey 2006
British Social Attitudes Survey 2006
Census 2001
European Social Survey 2008/09
Families & Children Study 2006
General Household Survey 2006
National Survey of Sexual Attitudes and Lifestyles 2000
Scottish Health Survey 1998
Scottish House Condition Survey 1996
Survey of English Housing 2004/05
Survey of Public Attitudes toward the Environment 2007
Workplace Employment Relations Survey 2004

economic status), producing 60 interacted quota cells. As before, respondents who were unsure of or unwilling to disclose any of the quota information had to be routed out of the survey.

4.2 Survey design

Survey items were sourced and adapted from existing large-scale surveys wherever possible, including those listed in Table 4.3. Existing items were favoured because in general they are extensively tested, potentially familiar to respondents, and enable comparison of results with published data.

A wide range of items were included in both surveys to support additional and future research: not all of the items are used in the analyses presented in this thesis. The London survey included a wide range of items on subjective wellbeing and subjective connection to nature. The UK survey instead included a range of items on exercise, physical and mental health, and the use and enjoyment of nature. Because extremely detailed EQ information is available for London, the design of the London survey also emphasised the elicitation of especially accurate location data for respondents' homes and workplaces.

4.2.1 London

The London survey is accessible at <http://www.wellbeingsurvey.org.uk/>⁸, and screenshots are shown in section A.3 of Appendix A. In this section, page references are to those survey page screenshots.

4.2.1.1 Happiness

Items were included to assess subjective wellbeing according to three distinct approaches. First, a standard single-item life satisfaction (LS) scale was used — item B24 on the 2006 European Social Survey (ESS) Round 3, listed as item O-SLW/c/sq/n/11/cd in Veenhoven's (2001) World Database of Happiness:

All things considered, how satisfied are you with your life as a whole nowadays?

0 (extremely dissatisfied) – 10 (extremely satisfied)

⁸Visited via this link, the survey displays slightly differently than it did to panel respondents: there are no screening questions (and quotas are not imposed); contact details on the Help page are the researchers' rather than the panel company's; there is an informative acknowledgement page at the end; and the connection is not encrypted.

ESS Round 3 module Second, the Well-being Module included in the ESS Round 3 was reproduced in full. Comprising 54 items, this module is expected to provide higher reliability than a single item measure, and measures wellbeing much more broadly than either a simple life satisfaction item or multiple domain satisfaction items do. It incorporates both hedonic and eudaimonic approaches to wellbeing, and both its individualistic and social/interpersonal aspects (Huppert et al., 2009). While relationships between basic external conditions and components of the wellbeing module in the ESS Round 3 data have been described for European countries (Michaelson et al., 2009), no associated data on local environmental quality has previously been available. The ESS Round 3 Well-being Module items are on pages SA-11 – SA-25 and SA-55 (excluding the last item on that page) of section A.3.

Vignettes Third, the single-item life satisfaction item was followed by a set of anchoring vignette items. Responses to these items are not analysed in this thesis.

4.2.1.2 Map locations

To calculate environmental quality (EQ) levels to which respondents are exposed at a very high resolution — and with a minimum of measurement error — it is necessary to discover respondents' spatial locations as accurately as possible. The survey therefore included a number of items regarding the location of the respondent's home and of one additional location in which the most time was spent (for example, the workplace). Respondents were also asked about their usual means of travel between these two locations.

For locations, respondents were asked initially for a full UK postcode. If respondents ticked a box to indicate they did not know the postcode, they were immediately asked instead for the name of the street and city/town. If neither of these items was supplied, respondents were asked on a later page, as a fallback, which was their nearest Tube or railway station. However, if either postcode or street and city/town were supplied — and as long as the respondent's browser supported JavaScript — these were used on the following page to set the starting centre position of an interactive map. Respondents were then asked to pinpoint the precise location by dragging the map so that the location was framed by a viewfinder in the centre, as illustrated in Figure 4.1. The latitude and longitude of the centre of the map, and the final map scale, were recorded alongside the other response data.

The initial map scale was set at approximately 1:3000 (the scale shown in Figure 4.1)⁹. This was felt to represent a good compromise between accuracy (higher at more zoomed-in scales) and respondent orientation and perception of privacy (higher at less zoomed-in scales). Respondents could zoom in by double-clicking, and could zoom in or out using the buttons at the top left of the map. However, if respondents zoomed out beyond the original scale, the following message was programmed to appear at the top right of the map: "When you're ready, please zoom in again to pinpoint a more accurate location". Following the interactive map item, respondents were asked to report the outcome of the task using one of the following options: My home is in the yellow box; My home is in or near the yellow box—it could be one or two buildings either way; I couldn't find my home on the map; The map didn't load/didn't work; I prefer not to say exactly where I live.

4.2.1.3 Demographic information

Standard demographic items were included, including gender, age, marital and relationship status, children and children's ages, qualifications, work status, and income (pages SA-4, SA-57 – SA-58 and SA-60). Because they are generally significantly associated with LS, and because income is important in valuing aspects of EQ, the age and income items used unusually numerous and narrow response bands in order to minimise measurement error. Income was requested at both individual and household level, and a special request was included for completion of these sensitive items.

⁹This is zoom level 17 on the Bing maps service. The map scale in metres per pixel is calculated as $156543.04 \cdot \cos(\text{latitude} \cdot \pi/180)/(2^{\text{zoomlevel}})$ (Pendleton, 2006). For London, at zoom level 17, this is $156543.04 \cdot \cos(51.5\pi/180)/(2^{17}) = 0.74$. A typical computer display has around 100 pixels per inch, and 1 inch = 0.0254 metres, giving 0.000254 meters per pixel. The map scale ratio is thus $0.74/0.000254 = 2927$.

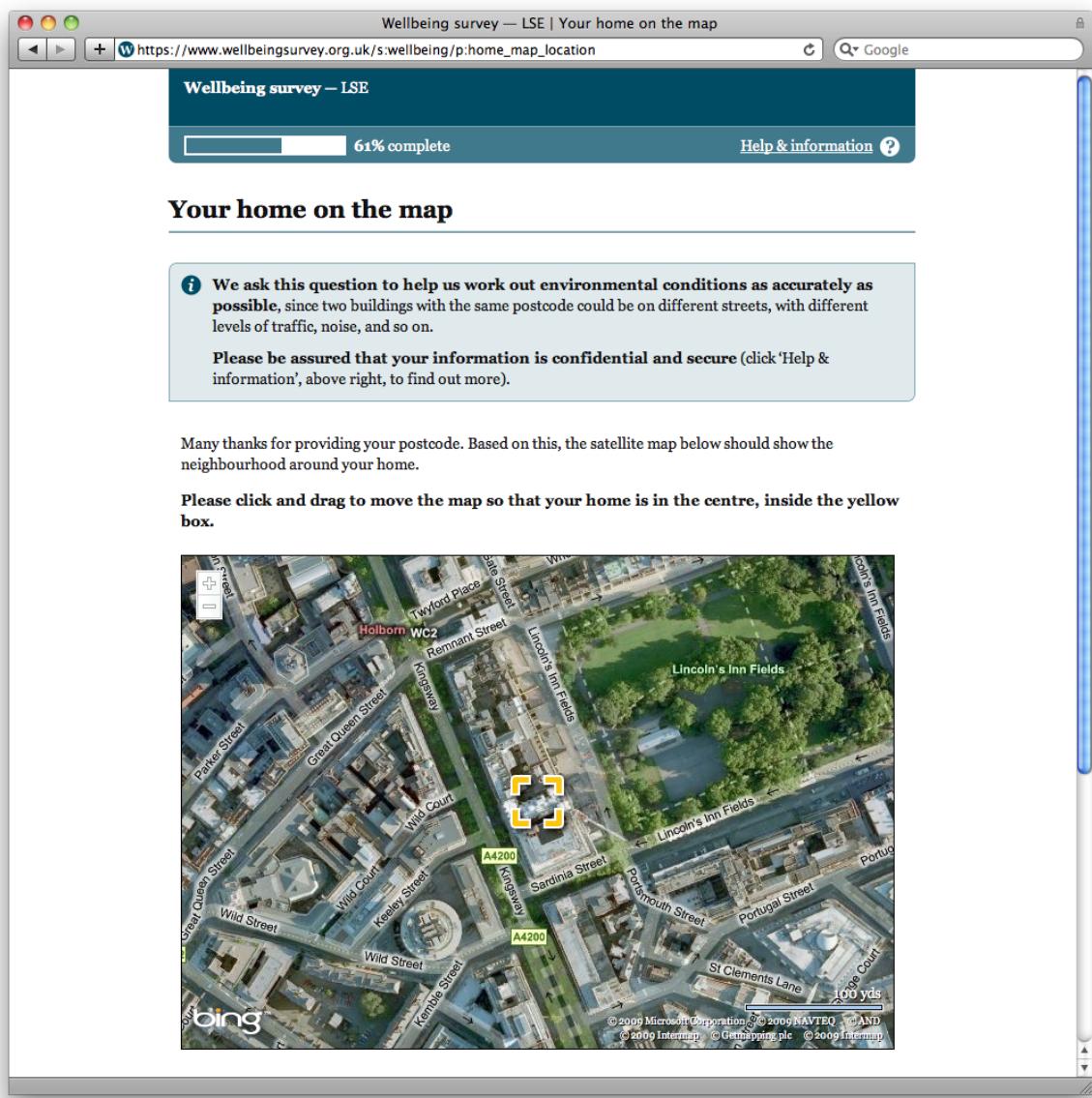


Figure 4.1: Interactive map item for home location

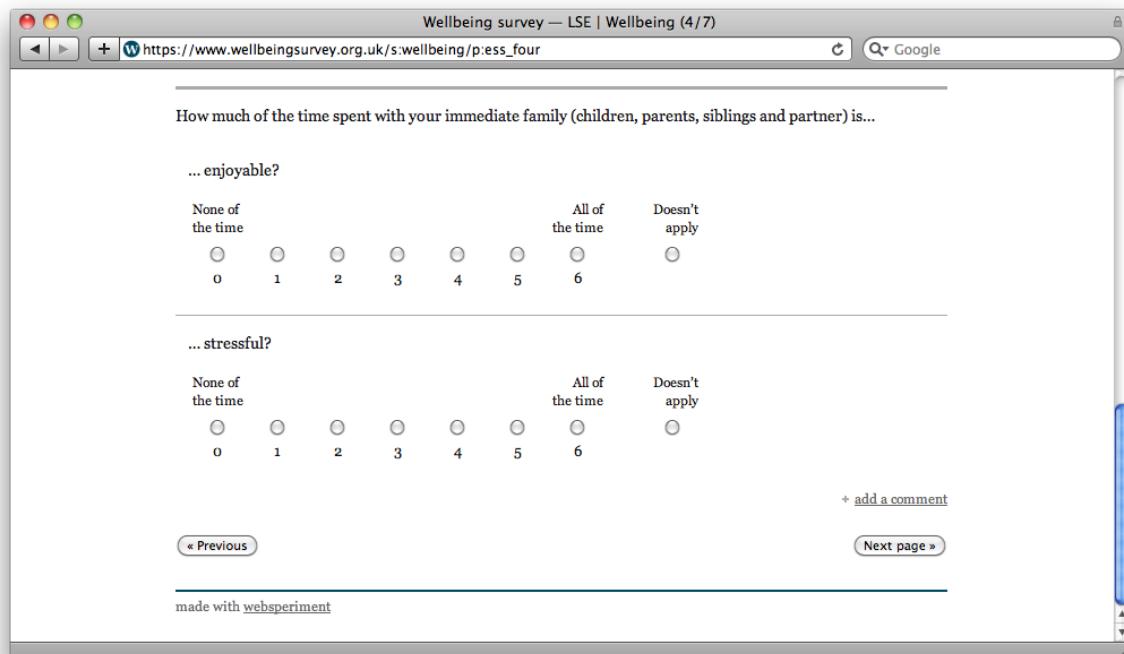


Figure 4.2: 'Add comment' link, and separation of non-scale options in scale items

4.2.1.4 Other items

A number of items on housing type and quality were included (pages SA-33 and SA-35 – SA-36, section A.3), as well as subjective perception items on the topic of the respondent's local environment, regarding litter, crime, personal safety, green space, air pollution, noise, and overall satisfaction (pages SA-43 – SA-44). Respondents were also asked about the existence of views across, and about their use of, different types of green spaces (pages SA-45 – SA-46 and SA-52), and presented with the 'self' and 'experience' factor items of a nature-relatedness scale¹⁰ (Nisbet et al., 2008) (pages SA-26 – SA-28). Respondents were asked how long they had lived in their present accommodation, and about the size of the settlement where they had lived previously, which might provide an indication of possible adaptation to current EQ (pages SA-33 – SA-34).

A number of further items were presented, on the hypothesis that these might be associated with LS ratings. These included items on physical exercise, health, diet and sleep (pages SA-29 – SA-30); working hours and activities (page SA-59); leisure activities (pages SA-53 – SA-54); religious beliefs and political affiliation (pages SA-61 – SA-62); family background (pages SA-63 – SA-65); external shocks or negative events occurring in the recent past (pages SA-66 – SA-67); and, where applicable, pregnancy and the menstrual cycle (page SA-68). Respondents were able to make free-text comments by using an 'add comment' link at the bottom of each page which expanded, when clicked, into a text entry field (see Figure 4.2 and pages SA-66 – SA-67).

The majority of these items are not analysed in this thesis.

4.2.2 UK

The UK survey can be accessed at <http://uk.wellbeingsurvey.org.uk/>. Screenshots are again shown in section A.3. As before, page number references are to screenshot pages in that appendix.

4.2.2.1 Happiness and health

The same standard single-item life satisfaction (LS) scale was used as in the London survey.

¹⁰"The NR-Self factor might be thought of as the ecological self, or how strongly people identify with the natural environment. [...] The NR-Experience factor reflects the physical familiarity and attraction people have to nature" (Nisbet et al., 2008, p. 18).

For general health, the SF-36 Health Survey was employed (pages SB-6 – SB-14). The SF-36 is the leading general health measure (McDowell, 2006, p. 662). It comprises 36 survey items, with standardised administration and item scoring to produce several validated sub-scales. The freely-available RAND version of the survey was used (Hays et al., 1993). Though we are aware of the benefits of standardised and validated scales, giving results directly comparable to previous research, we did make one small change. In the original item “How much of the time during the past 4 weeks did you feel full of pep?”, we replaced the word ‘pep’ with the word ‘enthusiasm’. We did so because ‘pep’ is a colloquial, archaic, American term not in common use in the UK.

To assess mental and emotional wellbeing more specifically the Positive And Negative Affect Schedule (PANAS) was presented (Watson et al., 1988; Crawford & Henry, 2004; McDowell, 2006, p. 225) (pages SB-15 – SB-18). The PANAS asks respondents to rate the applicability to their state of mind of twenty adjectives, and responses are summed to form negative affect and positive affect indicators. We opted for the standard PANAS time frame which most closely matches the ‘past 4 weeks’ period used throughout the SF-36, provided by the introductory text: “Indicate to what extent you have felt this way during the past few weeks”.

4.2.2.2 Location

In this survey, full home and (if applicable) work postcodes were requested (pages SB-4 and SB-54). Extremely precise location information was not believed to be as important as in the London survey, since for air pollution and noise — in which there is considerable variation over very short distances — data are not available UK-wide. Thus, for brevity, we did not present map location items.

4.2.2.3 Demographic information

As on the London survey, standard demographic items were included (pages SB-4 and SB-58 – SB-59). However, due to an error in survey implementation, the items regarding marital and relationship status, children and qualifications (page SB-58) were unfortunately not shown to most respondents. The web panel provider, Toluna, were able to supply some marital status and qualification information, but high rates of missing data limit the usefulness of this data.

As noted in subsection 2.5.2, evidence from existing studies on links between qualifications and wellbeing, and between having children and wellbeing, is mixed. By contrast, marital status is usually a substantial and significant predictor of SWB.

We use living alone as a proxy for marital/relationship status¹¹. We are not able to include indicators of qualifications or parenthood. However, in models using the London data, the qualifications and parenthood variables are not significant at the 5% level. Moreover, the inclusion or exclusion of marital/relationship status, qualifications and parenthood variables in the London models makes no difference in relation to EQ characteristics (that is, it does not cause any change in the sign or significance of coefficients, or any substantial change in their magnitude). It therefore seems likely that this error in survey implementation does not materially affect our findings.

4.2.2.4 Other items

As a measure of physical activity, the long-form self-administered International Physical Activity Questionnaire (IPAQ) was presented (Craig et al., 2003) (pages SB-39 – SB-52). In addition to the standard IPAQ items, we asked respondents to estimate the proportion of time spent in different forms of leisure-time exercise that was spent in natural environments. As on the London survey, several items on housing type and quality were included (pages SB-21 – SB-24), as well as a number of items regarding the respondent’s local environment (pages SB-25 – SB-27).

We asked a variety of additional questions regarding direct and indirect use and enjoyment of nature. These included: views from the home and workplace; membership of and intended

¹¹In our London data, living alone is significantly correlated with the two marital/relationship status variables we include in our models: not being in a relationship (correlation coefficient 0.37), and being divorced or separated (correlation coefficient 0.26).

legacies to wildlife and conservation organisations; visits to National Parks and National Trust and RSPB land; nature watching and photography; time spent in the garden, countryside and other green spaces; and experience of nature via exhibitions, magazines and television ([pages SB-27 – SB-38](#)).

Most of the other items from the London survey were also used, with the exception (for brevity) of those regarding work activities and hours, religious denomination, birth order, and pregnancy and menstruation. In addition, the item regarding external shocks or negative events was changed to refer to the past one year rather than the past three ([page SB-63](#)). This change was made because an unexpectedly large proportion of respondents on the London survey reported one or more shocks occurring during the three-year time frame.

The majority of these items are not analysed in this thesis.

4.2.3 Paradata

Paradata are data connected to survey completion which are not explicitly provided by the respondent ([Heerwegh, 2003](#); [Kaczmarek, 2008](#)). Various items of server- and client-side paradata were recorded alongside survey item responses in both surveys, principally for use in assessing response quality.

These items included: the time of the first viewing of each survey page (using this, the time spent on each page and on the survey as a whole can easily be calculated); the IP address and hostname of the respondent's computer, and the name and version reported by their web browser (the HTTP 'User Agent' header); the referring HTML page, if any (the HTTP 'Referer' header¹²); and the availability of JavaScript in the user's browser. For items where certain response options led to the immediate display of further items, a full history of the selected option state was recorded, using JavaScript on the client side, to check that respondents were not avoiding these options.

4.3 Implementation

4.3.1 Platform

The surveys were implemented using *websperiment*, a new platform developed by the researcher for this purpose, which has three distinctive aspects: it is a domain-specific language; it makes liberal use of inheritance and polymorphism, increasing modularity and reducing the extent to which layout and logic have to be duplicated throughout a survey definition; and it will be released under an open-source licence, enabling any researcher to extend and modify it, and then to share those changes. A significant motivation for the development of this platform was the desire to incorporate the interactive map location questions described in [subsubsection 4.2.1.2](#).

The *websperiment* code for both surveys is listed in [section A.5](#) on page 314 of Appendix A. Further details on the platform are provided by [MacKerron \(2011b\)](#), and that paper is reproduced in [section A.4](#).

4.3.2 Respondent experience

4.3.2.1 Item presentation

HTML form control types were carefully matched with item response types. Radio buttons were used for 'pick one' multiple choice items with a small number of response options. These were enhanced (where JavaScript was available) to allow a second click to clear the selected response. Drop-down boxes were used for 'pick one' response items with numerous options. These displayed 'Please select...' as the initially visible response option, which was coded as a missing response if not altered. [Couper et al. \(2004\)](#) discuss these controls in detail. Scale questions were presented with even spacing, and options that were not part of the scale were visually separated to prevent confusion (see [Tourangeau et al., 2004](#)), as shown in Figure 4.2.

¹²The referrer header is mis-spelled in the HTTP specification.

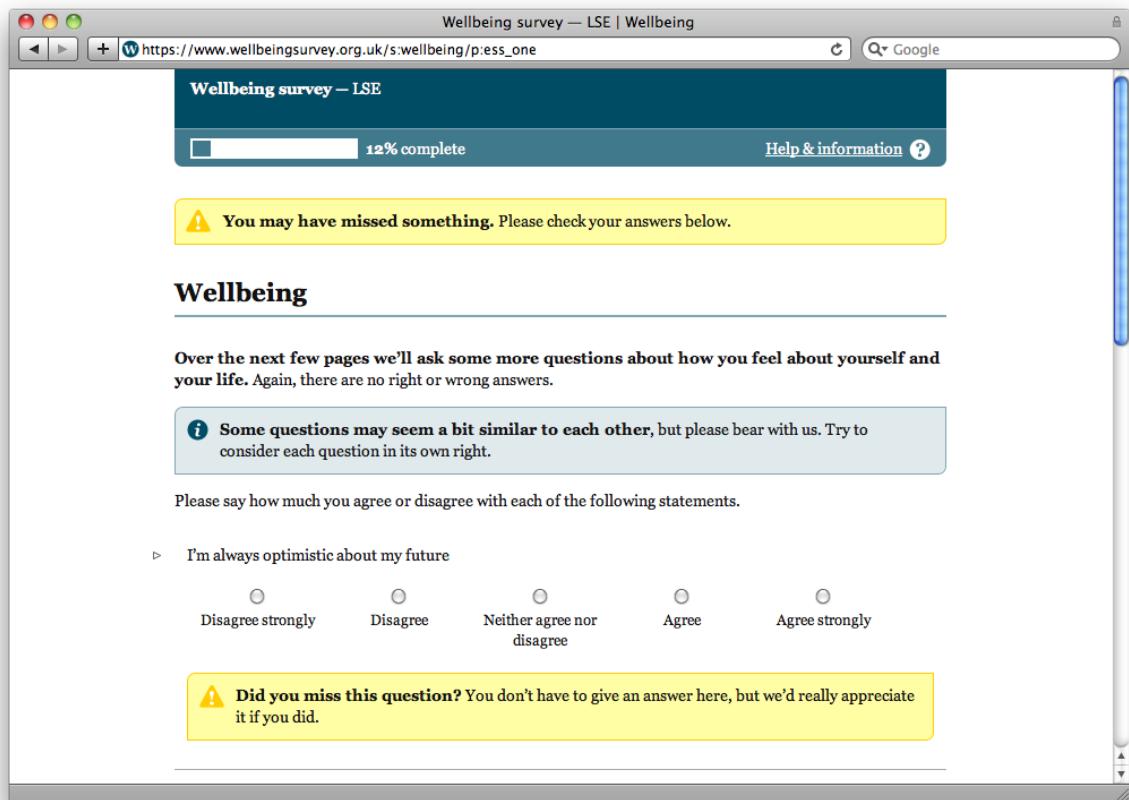


Figure 4.3: Prompting for completion

Check-boxes were used for 'pick several' multiple choice items. Where applicable, a 'None of the above' item was included in order to distinguish missing and non-missing responses. This was enhanced (where JavaScript was available) so that selecting this option deselected all others, and selecting any other option deselected this one. Free text entry field size was matched with the length of the expected response (Christian et al., 2007), and example text shown where appropriate.

4.3.2.2 Completion policy

Apart from the items required for checking eligibility and assigning respondents to quota cells, all survey items were optional but prompted, in line with recommended practice (e.g. Couper, 2008). Respondents who omitted any responses on a page were shown that page again. In most cases, the message "You may have missed something. Please check your answers below." was placed at the top of the redisplayed page, and the message "Did you miss this question? You don't have to give an answer here, but we'd really appreciate it if you did." shown immediately below each omitted question (see Figure 4.3). However, for key items such as LS, location and income, custom messages were substituted here: for example, for income items the message shown below the item read: "You don't have to give an answer here, but we would really appreciate it if you did. The wellbeing effect of income relative to other factors is one of the key issues in our research". Respondents could ignore these messages if they chose to simply by submitting the page again.

4.3.2.3 Paging vs. scrolling

The large number of items was judged to count against a one-item-per-page design, based on the number of extra mouse clicks that would be required. Items were instead assembled into thematic pages, some of which required scrolling¹³. This did not interfere with requirements for routing, since the survey software was able to show and hide items dynamically within a

¹³For a discussion of paging vs scrolling designs, see Peytchev et al. (2006).

single page. To help respondents navigate through long pages, a moving pointer was developed, highlighting the next unanswered item. On the UK survey, respondents could enable an optional ‘auto-scroll’ feature which automatically scrolled the next unanswered item into the centre of the browser viewport.

4.3.2.4 Item order

Several aims were traded off in sequencing the survey items. To improve completion rates, items judged more interesting or motivating were placed nearer the start, while more boring or sensitive items were placed nearer to the end. Items with similar content were as far as possible grouped together, and the progression between such groups made as smooth and logical as possible. Since subjective wellbeing items are known to be particularly vulnerable to context effects (e.g. Schwarz & Strack, 1999; Smith et al., 2006), these items were placed at the very beginning, and the survey’s introductory text did not mention any specific hypothesis or focus regarding influences on wellbeing.

4.3.3 Guidance, confidentiality, and informed consent

The introductory text was kept very brief (following feedback from the pilot phases) but included a link to more detailed information; this link was also present on all later pages. Information boxes — having a shaded background and a lower-case ‘i’ symbol at top left — were then used throughout the survey to provide additional guidance and feedback to respondents, as seen in all the Figures in this section.

The surveys were conducted in compliance with the London School of Economics research ethics policy. Respondents were informed that by completing the surveys they gave their consent to serving as a subject in the research study (pages [SA-1](#) and [SB-1](#), section A.3). To ensure confidentiality of responses on the London survey — in which participants identified their home location very precisely — this survey was conducted over an encrypted (HTTPS) connection. In both cases the hosting server was fully updated, firewalled, and accessible to the researcher only via an encrypted (SSH) shell.

4.4 Piloting

4.4.1 London

A detailed pre-pilot of the London survey was conducted with ten individuals, who were asked to provide detailed comments on their experiences both overall and on each page of the survey (an additional question was inserted automatically at the end of every page to allow for this). Based on feedback from this exercise, a series of minor changes were made. These included: clarifications to the wording of some items, response options and guidance sections; tweaks to the survey’s visual appearance (for example, the progress indicator was made more prominent, and all text was darkened slightly); and bug fixes to the underlying survey framework.

Several pre-pilot respondents commented on the excessive length of the survey. A number of questions having relatively weak existing evidence of a link with LS were therefore dropped. In addition, a dedicated page explaining the survey’s purpose and seeking informed consent, immediately following the introductory landing page, was eliminated. Pre-pilot respondents felt that this page presented too much text and was excessively bureaucratic, and that this made them uncertain whether they would be willing to continue¹⁴. The information from this page was abridged, broken into titled sections, and moved to a new ‘Help & information’ page, highlighted on the introductory page and accessible throughout the survey.

The survey was subsequently piloted on a larger scale using an email snowball sampling method, giving 181 respondents prior to the full survey launch. No additional issues were identified from this pilot data. Please note that all screenshots and descriptions in other subsections relate to the final, post-piloting version of the survey.

¹⁴It seems possible that respondents to web surveys have somewhat different expectations than they would for other survey media. People don’t like to (and often simply don’t) read on the web (Nielsen, 1997).

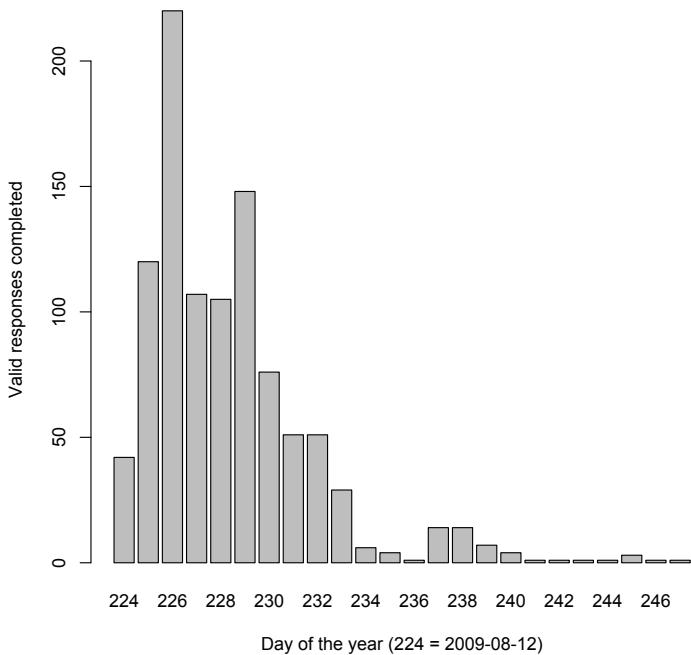


Figure 4.4: Valid London survey responses, by day

4.4.2 UK

Results from the UK survey were required to inform the UK National Ecosystem Assessment ([UK NEA, 2011](#), p. 33). Because of time pressure on this project, it was unfortunately not possible to conduct a full pilot of the UK survey. However, almost all items on this survey had previously been piloted either in the form of standardised scales (e.g. SF-36, PANAS) or as part of the London survey, and lessons from the London survey also informed the wording of instructions and guidance, and the visual and technical implementation, which were kept as similar as possible.

4.5 Completion by web panel

To guard against context effects and self-selection bias, emails to web panel members were worded rather generically. Although the messages did mention wellbeing as a subject of the study, they did not mention environmental quality or any other possible influences on it. A sample survey invitation is reproduced in [section A.2](#).

4.5.1 London

For the London survey the web panel company, Toluna, began emailing batches of invitations to their panel members on 12 August 2009. In total, 1,008 valid responses were received. The number of valid responses completed each day is shown in [Figure 4.4](#) (a peak was reached within three days, while most quota cells remained open; as more quota cells became full, progressively fewer respondents were accepted to complete the survey). Following a period of minimal additional completions, sending of invitation emails ceased on 1 September.

4.5.2 UK

Toluna panel members were invited to complete the UK survey starting on 23 August 2010. 1,976 valid responses were received, following a similar temporal pattern as in the earlier survey. The last invitation emails were sent on 14 September.

4.6 Data quality and cleaning

Because of the incentives for web panel respondents to provide invalid data, as outlined in subsection 4.1.2, survey response sets were analysed regularly during the completion period to ensure validity. Response sets identified as invalid were immediately excluded from quota cell totals.

In addition to the raw survey data and paradata, a set of approximately 30 further quality indicators was calculated for each completed response set using a custom Ruby program. Values potentially indicating an invalid completion were flagged. Any response set flagged two or more times was subject to scrutiny and possible exclusion by the researcher (exclusion was not a mechanical process: some indicators and indicator values were given more weight than others, and the combination of indicators was also taken into consideration).

4.6.1 IP address and location

An IP address is a numerical label assigned to any device connected directly to the Internet (e.g. 129.31.242.240). A hostname is the unique name by which a network-attached device is identified (e.g. dyn1242-240.vpn.ic.ac.uk).

Any response sets having an IP address in common were flagged, as potentially being multiple completions by the same respondent. IP addresses were also used to geolocate respondents¹⁵. Respondents reported as located outside the UK were automatically excluded (unless geolocation placed them in the United States — a relatively common error). IP addresses were also converted to hostnames by reverse lookup where possible, and the hostname top level domain (e.g. .uk, .cn, .edu) corroborated with the geolocation result. The top-level domain of the referring web page (which often indicated a web-based email system) was also cross-checked. Although these IP-based checks could be circumvented by respondent use of UK proxy servers (Norman, 2009), they do significantly raise the bar for committing undetected response fraud.

4.6.1.1 London

For the London survey, IP-derived locations outside London were flagged. In addition, the respondent's home postcode, if provided, was associated with a local authority or borough¹⁶. This was flagged if it did not match the London borough reported by the respondent on the second screening page.

4.6.2 Patterns and consistency

Where a long series of items was presented with the same response scale, responses were checked for regular patterns. For example, on the London survey, such item series occurred on the nature relatedness page and four of the ESS Round 3 Well-being Module pages. For each item series, the absolute differences between each response and the response following it were calculated. For example, given a response sequence 1-2-5-6-3, the absolute differences are 1-3-1-3. A series of identical differences was flagged as a regular pattern. This algorithm recognises both 'straightliners' (difference sequence 0-0-0-...) and other zig-zag response patterns (sequences 1-1-1-..., 2-2-2-..., and so on). Of course, like other techniques in this section, this algorithm may produce both false negatives (occasionally flagging legitimate responses) and false positives (sometimes failing to flag invalid responses, such as those selected completely at random), which is why the full set of validity indicators was evaluated on a case-by-case basis.

In addition, to help identify responses selected completely at random, pairs of items identified as related were checked for logical consistency. For example, on the London survey, a response could be flagged as inconsistent on up to 13 grounds, including where:

¹⁵The MaxMind GeoLite City database, August 2009 revision, was used. It is available at <http://www.maxmind.com/app/geolitecity>. The database has a stated accuracy of 99.5% at country level.

¹⁶This association was made using the Yahoo! GeoPlanet APIs (Application Programming Interfaces), available from <http://developer.yahoo.com/geo/geoplanet/>.

- satisfaction with 'your life as a whole' and with 'how your life has turned out so far', answered on the same scale, differed by three or more points;
- respondents indicated that they had spent most or all of the week feeling happy *and* most or all of the week feeling sad¹⁷; and
- individual income was stated as higher than household income.

4.6.3 Speed

All surveys completed in under 10 minutes were flagged. In addition, items were flagged in cases where the response option selected did *not* lead to the immediate display of additional items on the same page, but the respondent was recorded as having initially selected a different option, which did. For example, a flag would be raised for a respondent who indicated that they smoked but, when confronted with a follow-up question regarding the extent of their smoking, changed their mind. On the London survey this behaviour was capable of detection on eight items.

4.6.4 Corrections

Given the importance of location to our study, postcodes that could not initially be geocoded were checked manually. For example, on the London survey, 11 postcodes were corrected by removing extraneous spaces or punctuation characters, or substituting characters that are visually similar and/or close on the keyboard: 0 and O, and 1 and I and !.

4.7 Summary

This chapter has described the survey data collection underpinning our first research strand. A significant effort has been made to assure the quality of the data, through careful design of the survey instruments and rigorous checking of the responses provided. The data is unique in combining high-resolution location information and several types of detailed SWB evaluations, alongside appropriate controls. This enables us to address our research questions in such a way as to advance the present state of the literature, as described in [subsubsection 1.2.1.3](#).

As part of this undertaking we have also developed a new platform for the implementation of flexible and attractive web-based surveys and experiments, outlined in [subsection 4.3.1](#), which we hope will be of future benefit to researchers across disciplines.

¹⁷Although possible, it is unusual to feel happy and sad at the same time ([Larsen et al., 2001](#)).

Chapter 5

Spatial experience sampling methods

This chapter describes the spatial experience sampling data collection methodology we develop and implement as part of our second research strand, looking at momentary SWB in relation to people's immediate surroundings. Elements of this method are entirely novel, and the whole is novel in the contexts of happiness economics and studies of the impacts of EQ. We therefore provide a reasonably thorough exposition, although certain details, and the most technical aspects of the implementation, are elaborated further in Appendix B.

The data set collected by this method is related but rather different to that gathered in the survey research described in the previous chapter. Here we ask individuals for simple, instantaneous assessments of SWB alongside some contextual information. While they answer, current location is recorded, which is later used to join responses with other spatial (and time-varying) data. For each study participant there are repeated interactions, producing a large, panel-structured data set. This data set allows us to approach our over-arching subject — links between happiness and EQ — at a more detailed and disaggregated level than has previously been attempted: not at country or even person level, but at the scale of individual, momentary experiences.

5.1 Priorities

We focus on an EQ indicator for which high-resolution UK-wide data are available: land cover types (to be discussed further in the next chapter), including different types of green and blue space. To test our research hypothesis on links between momentary happiness and EQ will therefore require that we observe amongst our ESM assessments some experiences of these natural environments. These experiences are expected to occur with relatively low frequency, and may have only a moderate impact on happiness. We may thus need to collect a large number of ESM assessments in order to obtain enough relating to the natural environment for our hypothesis tests to have reasonable statistical power.

For this reason a key priority informing many aspects of the study's design, implementation and operation is to maximise the number of participants recruited, and the number of assessments completed by each. This implies a number of subordinate objectives, including:

Low participant burden Signing up and continuing to take part in the study both need to require as little as possible in terms of time, logistical difficulty and cognitive effort. These processes should be fast, simple, attractive and — ideally — fun. They will ideally involve no typing. They should be capable of completion using only the participant's handheld device — for example, there should be no need to meet or speak to researchers, or use a desktop computer. We will want to minimise the amount of information requested from participants.

High participant motivation It is important to reach and then motivate prospective participants to sign up to the study, and to keep existing participants engaged in taking part. This will require us to produce and publicise information about and data from the study in an accessible and interesting format. Keeping participants engaged may also be assisted by the provision of stimulating feedback about their own responses, especially if the value of this feedback increases with the degree of participation.

Low researcher burden In order to support a large number of participants and responses, each participant and each response must not require a large investment of researcher time, logistical support, or money (since none of these is in abundant supply). For example, it would be impractical to ask a large number of open-ended questions requiring manual coding.

High scalability The system obviously must be capable of handling the desired large volume of participants and responses.

The remainder of this chapter describes how the study was implemented and how these objectives were met.

5.2 Survey design

5.2.1 Registration survey

As part of the process of signing up to take part in the study, participants complete a brief survey providing data about themselves. The full text of this survey is reproduced screen-by-screen in subsection B.1.1 on page 358 of Appendix B.

Life satisfaction The first screen presents a standard life satisfaction (LS) item. It is based on the European Social Survey item used in the two web surveys (see subsubsection 4.2.1.1). However, owing to constraints of space on the iPhone screen, the preamble ‘All things considered’ is eliminated from the question text, and the response scale is truncated to run from 1 – 10 instead of 0 – 10. We ask this generalised and evaluative/cognitive wellbeing question for comparison with individuals’ later momentary assessment responses.

Health We then present a simple, standard self-assessed health item (the response categories here are the same as used in the Canadian National Population Health Survey, for example). We ask this question because health status is invariably an important predictor of wellbeing responses in the literature. We also ask a simple Yes/No question about asthma and other respiratory disease, because these factors may mediate the impact of air pollution on wellbeing¹.

Demographics We next ask questions on gender, age, marital and relationship status, work status and household composition. The age question is framed as year of birth — this provides year-level precision, and is known to give high accuracy and low non-response rate compared to other options, such as a choice of age bands (Healey & Gendall, 2008).

We ask these demographic questions in order to characterise our sample in relation to the wider population; because age, marital/relationship status and work status have strong associations with wellbeing in the literature; and because information on household composition allows us to calculate equivalised income levels using the income data discussed next.

Income Finally, we present questions on income. We first ask about gross annual household income, providing 11 response bands, with fairly wide bands at the very bottom (since iPhone owners are not expected to be very poor) and across the top end (reflecting the diminishing marginal utility of income). We also provide “Don’t know” and “Prefer not to say” options because of the relative difficulty and sensitivity of the question.

We ask this question in order to characterise our sample in relation to the wider population; because previous research finds a significant positive effect of income on wellbeing; and because income information may enable us to use wellbeing responses for monetary valuation.

¹Individuals with underlying diseases of the airways are known to be more susceptible to the respiratory effects of air pollution (Utell et al., 2005, pp. 121 – 126). If the Mappiness data were to be used in future research on links between air pollution and SWB, it could be informative to specify a model including an interaction term between respiratory disease and estimated air pollution exposure. One might hypothesise that this interaction term would be negatively related to predicted SWB over and above any negative effect of the simple air pollution exposure variable.

Second, we ask up to two somewhat experimental questions about changes in income over the past 3 years: whether there has been a change up or down and, if there has been, the magnitude of the change in one of 6 bands (defined in absolute money amounts). Again we allow “Don’t know” and “Prefer not to say” responses. We ask this question because lagged income has been shown in many studies to be an important correlate of wellbeing, and its omission in valuation studies may lead to an upward bias in SWB-derived valuation estimates (Welsch, 2009, p. 2741).

Bound et al. (2001) discuss general problems associated with defining income and collecting income data by survey, while Micklewright & Schnepf (2010) highlight issues with single-question income measures in relation to household income in particular. As noted in section 5.1, we attach great importance to speed and ease of use for participants in our ESM data collection process. We therefore do not attempt to address these income data issues through routes that would add to the burden associated with survey completion — such as through the use of ‘cheap talk’ entreaties, listings of potential sources of income (as were provided in our web survey instruments), or presentation of multiple income-related questions. For this reason, it seems possible that the income data we collect are subject to greater bias than the income data collected in some other surveys. This has relatively little bearing on the present work, however, since income data are not used in the main happiness analyses reported.

5.2.2 ESM assessment survey

5.2.2.1 Typical ESM assessments

ESM assessments are designed to capture both internal and external dimensions of experience. Measurement of the internal dimensions varies depending on the focus of a particular study. Typically, four key external dimensions are measured (Hektner et al., 2007, pp. 43 – 44):

1. the date and time of signalling and of the participant’s response;
2. the participant’s companionship, eliciting descriptions such as ‘with parents’, ‘with friends’ and ‘with coworkers’;
3. the participant’s location, eliciting descriptions such as ‘in the kitchen’ or ‘at my desk at work’; and
4. the activity or activities in which the participant is engaged (participants are often required to identify ‘primary’ and ‘secondary’ activities).

ESM surveys tend to ask a large number of questions concerning the internal dimensions of experience — Hektner et al. (2007, p. 49) estimate that around 35 items is standard — in addition to several questions regarding each of the external dimensions. Questions on both internal and external dimensions commonly include open-ended questions, such as “Where were you?” or “What was on your mind?”. A sample ESM survey form is shown in Figure 5.1.

5.2.2.2 Mappiness ESM assessment

As previously discussed, our ESM assessment is intended to be as brief and as undemanding as possible. No open-ended items are employed². For participants, open-ended responses would be more cognitively demanding, slower, and awkward to enter using the iPhone’s on-screen keyboard. In addition, manual coding of the answers would be infeasible if the large desired sample were to be achieved.

The first external dimension of experience listed above, time, is captured automatically. Using the iPhone’s sensing capabilities the second dimension, location, is extended to include the participant’s objective geographical coordinates, and two further dimensions are added: noise level, and an image of the participant’s immediate environment. These sensed data are discussed further in subsection 5.4.2.

The full text of the ESM assessment survey is reproduced in subsection B.1.2 on page 360 of Appendix B.

²Update 1.1 of the app, released in May 2011, added a ‘Notes’ item for free text entry, but this is an optional item intended primarily for participants’ own use.

Date _____ Time you were beeped _____ a.m./p.m. Time you responded _____ a.m./p.m.

As you were beeped ...

Where were you? **Please be specific**

What was the main thing you were doing? **be**

What else were you doing at the same time? **specific**

What was on your mind? _____

What was on your mind? _____

Were you alone... Yes _____ No _____ . . . or were you with...
(please check all that apply)

Your Spouse _____ Your Boss _____ Co-workers _____ Friends _____ Girl/Boyfriend _____

Your Mother _____ Your Father _____ Teacher _____ Classmates/peers _____ Other(s) _____

Your children(s) _____ (please indicate who)

Your sibling(s) _____ (please indicate who)

Think back on how you got into this activity ...

Were you doing this main activity because you . . . (check all that apply)

(1) wanted to _____ (2) had to _____ (3) had nothing else to do _____

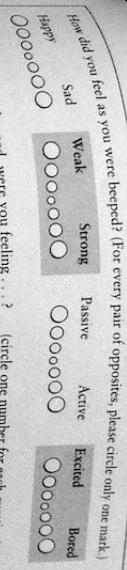
Indicate how you felt about the main activity. (please circle one number for each question)

Not at all	A little	Somewhat	Very much
0	1	2	3

Not at all A little Somewhat Very much

Did you feel as you were beeped? (For every pair of opposites, please circle only one mark.)

As you were being beeped, were you feeling . . . ?	(circle one number for each question)				
	Not at all	A little	Some what	Very much	
	0	1	2	3	Worried
	0	1	2	3	Caring
	0	1	2	3	Irritated
	0	1	2	3	Relaxed
	0	1	2	3	Stressed
	0	1	2	3	Proud
	0	1	2	3	Friendly
	0	1	2	3	Hardworking
	0	1	2	3	Productive
	0	1	2	3	Competitive
	0	1	2	3	Scared
	0	1	2	3	Angry
	0	1	2	3	Responsible
	0	1	2	3	Frustrated
	0	1	2	3	Competitive
	0	1	2	3	Scared
	0	1	2	3	Angry
	0	1	2	3	Responsible
	0	1	2	3	Frustrated



If you were talking with people, please answer the following 3 questions:

Not at all	A little	Some- what	Very much
0	1	2	3

Were you able to express your opinion? _____

Were others really listening to what you had to say? _____

Did you care about what others were saying? _____

If you felt a strong emotion since the last report, what did you feel and why did you feel that way?
I felt _____ because _____

Please be specific

If anyone else you were with expressed a strong emotion to you since the last report, what did they feel and why?
(who) _____ felt _____ because _____

Please be specific

COMMENTS, ETC.

Figure 5.1: Sample ESM survey form reproduced from Hektner et al. (2007, p. 296)

Wellbeing The information we collect on the internal dimensions of experience is limited to three simple items. We present these on the first screen of the ESM assessment survey. Visual analogue scales are used, implemented as slider controls, because of their sensitivity to small variations and (somewhat subjectively) because the user experience is enhanced by their high degree of interactivity. Participants are asked to rate the extent to which they feel 'happy', 'relaxed' and 'awake' on these scales, in each case between 'not at all' on the far left and 'extremely' on the far right.

The 'happy' response is of primary interest in this study. The other two adjectives were chosen as being reasonably orthogonal to happiness and to each other, and as being plausibly affected by environmental factors. In all three cases we chose familiar, everyday terms in order to increase acceptance by participants, and presented unipolar items for simplicity (a bipolar item scale, by contrast, might put 'very sad' on the left and 'very happy' on the right). We chose to emphasise positive aspects of mood in each case — 'happy', 'relaxed' and 'awake' rather than 'sad', 'stressed' and 'tired' — to help communicate the study's positive purpose and emphasis on positive impacts on wellbeing, and for simplicity and consistency of the relevant survey screen.

Companionship We next ask whom the participant is currently with. The participant can tap 'Alone, or with strangers only' to proceed immediately to the next question, or tick all applicable categories and then tap 'Next'. The categories offered are based on those used in previous ESM surveys.³

Location type To provide context for the GPS-sensed location coordinates we then present two simple items regarding location type. We ask whether the participant is indoors, outdoors or in a vehicle, since this is expected to be an important mediator of the impact of the outdoor environment — for which spatial data is available — on wellbeing. And we ask whether the participant is at home, at work, or neither: first, because the home and work locations may have important non-environmental effects on wellbeing; and second, because they are likely to account for a large proportion of the participants' time, and their associated environments may therefore represent an important baseline for other environmental experiences.

Activities Next, we ask what the participant is currently doing. For simplicity, we present a single list of activities (as an alternative, we initially considered using some form of nested categorisation). Participants are asked to tick all activities that apply. To proceed, at least one activity (or the final option, 'Something else') must be ticked. Again for simplicity, we do not ask participants to distinguish between primary and secondary activities.

The list of activities presented is informed by three sources: the UK 2000 Time Use Survey Activity Coding List ([Office for National Statistics, 2003b](#), Appendix 3), the American Time Use Survey 2009 Activity Lexicon ([Bureau of Labor Statistics, 2009](#)), and the large-scale ESM study by [Killingsworth & Gilbert \(2010\)](#). Drafting a single list of activities that is comprehensive but of a manageable length requires subjective judgment and some challenging compromises. For example, certain of our activities are arguably too broad — 'Shopping, errands' has to cover both the purchase of mundane necessities and shopping undertaken as a leisure activity ('retail therapy'). Similarly, certain activities that represent arguably distinct experiences are combined into a single category: 'Hunting, fishing', for instance.

The activities are presented in a broadly thematic order, proceeding from work-related activities through chores and errands to leisure activities. We considered randomising the order of response options per response or per participant to counter possible ordering effects. However, the disadvantages of this approach were considered to outweigh the benefits. Both forms of randomisation would result in an arbitrary ordering of items that would be more difficult to navigate. In addition, per response randomisation might confuse participants, and would prevent any learning of the list order, again impeding navigation of the list.

The activities list was updated once after launch, with app update 1.0.2 in September 2010. Five new categories were added: 'Intimacy, making love', 'Texting, emailing, social media', 'Browsing the Internet', 'Drinking tea/coffee', and 'Birdwatching, nature watching'. The first four categories were added based on participant feedback. The last, 'Birdwatching, nature watching' was added

³For brevity, we do not distinguish between being alone and being only with people unknown to the participant.

because we thought it a potentially important omission in relation to experiences of natural environments.

Adding activity categories inevitably results in reduced comparability of responses made before and after the change. To maximise comparability, however, we changed the coding of the ‘Something else’ option in the same app update, to reflect that this was now an option encompassing a narrower range of activities.

Notes In app update 1.1 participants were enabled to add optional textual notes, using a button provided at the end of the activities list. This feature was added primarily to increase the usefulness of the downloaded data to participants, and so act as an incentive to participation. However, if patterns emerge in the words or phrases used, it could also prove useful in assessing what items and/or options should be added to the survey in the future.

Photo The participant may next be asked to take a photo straight ahead. By default, we ask this only when the participant has indicated that he or she is outdoors — both for reasons of privacy, and to save time on the majority of assessment occasions. However, as of app update 1.0.2 participants can choose instead to be prompted for a photo on every occasion, or not at all (and can also choose, in response to several participant requests, to have all photos taken within the app saved to their on-device photo album).

The participant can decline the request to take a photo by tapping ‘Cancel’. After taking a photo, the participant can tap either ‘Retake’ or ‘Use’. If the participant successfully takes a photo, he or she is then asked whether it may be added to the map on the public website.

Location accuracy If the participant has indicated that he or she is outdoors, an accurate location estimate should also be obtainable by the GPS sensor, and is particularly important to our research. In this case, therefore, if the accuracy of the GPS-reported location is worse than $+/- 100\text{m}$ then the participant will be asked to wait while the device continues to try to determine location. This location accuracy screen dismisses itself automatically after 60 seconds or as soon as location accuracy reaches $+/- 100\text{m}$ or better. The participant is also able to tap ‘Skip’ to proceed at any time.

5.2.3 Item order and context effects

In the design of the registration and ESM assessment surveys, the same principles of item ordering were followed as in the web surveys, as discussed in [subsubsection 4.3.2.4](#). In each case the wellbeing item is presented first, to minimise context effects (for the ESM assessment, the item is presented immediately upon app launch if an assessment is pending). In the registration survey, the income items are presented last, being probably the most sensitive. Again to minimise context effects — and the possibility of induced correlation — no mention is made in the surveys or in any in-app feedback of the research hypothesis or of environmental factors.

5.3 Signalling protocol

Random, variable-interval assessments initiated by a researcher-induced signal are standard in ESM and common in EMA studies. Assuming perfect compliance, such ‘signal-contingent sampling’ provides a representative and unbiased selection of participants’ experiences ([Shiffman, 2007](#)). Conversely, assessments initiated at participants’ discretion may be unrepresentative due to self-selection, while assessments at regular, predictable intervals may be unrepresentative because of regularities in activities or moods, or because participants can modify their behaviour in anticipation of an assessment ([Reis & Gable, 2000](#), p. 198).

5.3.1 Scheduling

A simple, random, and entirely non-predictable algorithm for scheduling assessments could rely on a fixed probability of signalling each respondent in each of many brief time periods. For example, to signal each participant on average once a day, we might cycle through the participant list every minute during the 720 minutes between 8am and 8pm and, for each participant, signal him or her with a probability of 1/720. In practice, this simple algorithm is almost certainly *too* random. Using it, participants would occasionally experience very long or very short gaps between signals. Very long gaps might lead them to suspect a malfunction, while very short gaps could cause significant annoyance (and produce identical or near-identical responses that would add little information to the data set).

Instead, most previous studies have therefore split the day into fixed blocks, and signalled each participant at a moment picked at random within each block, often subject to a constraint on the proximity of consecutive signals (Hektner et al., 2007, p. 41). For example, Turk et al. (2007, p. 209) define three blocks (8am – noon, noon – 4pm, and 4 – 8pm) and ensure that consecutive signals are “scheduled to occur no closer than 2 hours apart”.

Unfortunately, using fixed blocks increases the predictability of the schedule. For example, in the study by Turk et al., if I have not been signalled by 11.50am then I know that I will be signalled in the next 10 minutes, and if I am then signalled at 11.55am I know I will not be signalled again before 1.55pm. Using fixed blocks also makes it complicated to maintain a uniform random sample of moments while also constraining the proximity of consecutive signals. (Researchers have generally not revealed how their constraint on the proximity of consecutive signals is implemented, but various naïve implementations — such as discarding schedules where the constraint is broken, and re-randomising until the constraint holds — would lead to significant under-sampling of the periods on either side of the switch-over between consecutive blocks).

To reduce (although not eliminate) predictability, and to maintain a uniform random sample with relative ease, the algorithm developed for Mappiness effectively also randomises the start and end times of blocks. This algorithm operates as illustrated in Figure 5.2, which shows example calculations for a participant who is to be beeped three times between 8am and 8pm, as in the Turk et al. study.

5.3.2 Signalling period, hours and frequency

Having chosen a scheduling algorithm, three key parameters of the signalling protocol remain to be set. These are: first, the total period during which participants will be signalled; second, the frequency with which signals will be sent (the product of these first two parameters being the total number of signals per participant); and third, since we do not want to interrupt participants’ sleep, the hours of the day during which signals will and will not be sent.

Most previous studies have employed a fixed total period and frequency across all participants. Periods have ranged from a few days to several months, and frequencies have varied between 1 and more than 10 signals per day. Delespaul (1992) offers some rules of thumb: 10 signals daily may be acceptable over a period of one week, while sampling over longer periods should not exceed 6 signals/day. The choice of parameters is influenced by the frequency of occurrence of the phenomena of interest, the quantity of data required for anticipated analyses, and the degree of burden on participants (Hektner et al., 2007, pp. 40 – 42).

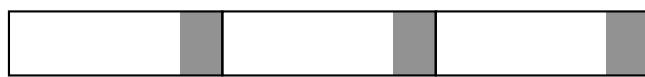
Many studies have also used fixed hours of the day: for example, Csíkszentmihályi & Schneider (2001) signalled all participants between 7.30am and 10.30pm. However, this approach is far from ideal. First, it requires that the signalling hours be truncated at each end to accommodate the majority of waking and sleeping times. Most participants will thus not be signalled across the full length of their waking days, compromising the representativeness of the sample of experiences (Stone & Shiffman, 2002, p. 238). Second, potential participants with an unusual or variable pattern of waking hours, such as those working shifts, are effectively excluded from taking part.

As discussed above, Mappiness seeks to analyse the association of mood with experiences of green and natural environments that are expected to be both rare and of only moderate influence on it. Therefore we wish to maximise both participation rate and the number of signalled assessments per participant. With this aim — and also respecting the diversity and autonomy of participants

a) Allocate blocks of equal duration



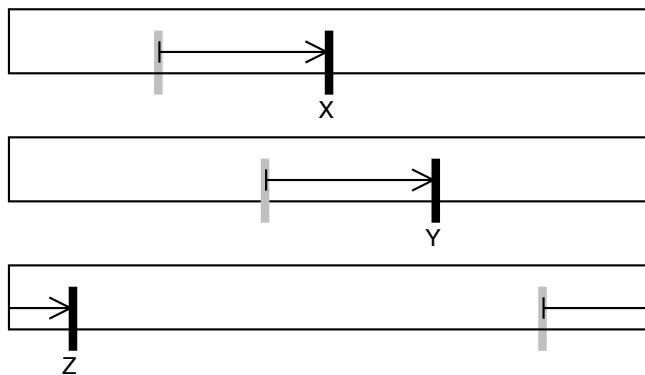
b) Allocate buffers at block ends (duration: $0.25 \times$ block duration)



c) Pick a random moment within each block, avoiding buffers



d) Move each moment forward by the same period, randomized between 0 and the block duration, wrapping from the end of the day to the start



e) Result

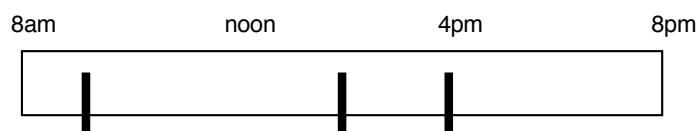


Figure 5.2: Example beep schedule calculation using Mappiness protocol

— Mappiness places all three parameters under participants' control, subject to conservative, low-burden minima/maxima and defaults.

The frequency of signals can at any time be set to 1, 2, 3, 4 or 5 per day, with a default setting of 2. Participants can at any time choose the hours during which they may be signalled, specifying start and end times to the nearest 15 minutes, with a default range of 8am – 10pm⁴. The total period of participation is unbounded: participants are asked to take part for as long or short a period as they wish, and instructed that they are free to opt out of the study whenever they choose. Because we hope that participants will find interest and value in taking part, we do not wish to restrict their ability to continue doing so, while also contributing useful data. And although some researchers have found that data quality from an individual diminishes after 2 – 3 weeks of sampling (Beal & Weiss, 2003), any such effect may be detected and dealt with as necessary.

5.3.3 Reachability and response

Certain requirements inevitably restrict the sample of experiences captured by a signal-contingent sampling study. For a signal to be received and a response given, a participant must be:

1. in possession of the signalling device (which must be charged and switched on);
2. in an area with wireless data reception (e.g. not on an underground rail system or in a remote rural area);
3. able to hear the signal (e.g. not at a noisy bar or building site);
4. able to safely respond (e.g. not driving); and
5. willing to do so.

Use of the iPhone has a number of advantages over traditional pager- or PDA-based ESM protocols in relation to the first point. The device is portable and convenient. Since it is already owned and provides many other functions to the user, it is also likely to be kept charged, switched on and within reach without any additional burden on participants.

Regarding the second point, base stations operated by all UK mobile communications providers now cover the vast majority of the country. Remote, rural locations, which are likely to be of particular environmental interest, are unfortunately also the least likely to enjoy coverage, however.

5.3.3.1 Missing and delayed data

If any of the five requirements listed above is not met, the response to a signal may be missing or delayed. Various choices have been made in previous studies regarding the protocol to be followed in this case. In some studies, participants are permitted to complete an assessment only if they react to a signal 'immediately' (e.g. within 30 seconds). In other studies, participants are given a longer period in which to respond — during which reminder signals might or might not be sent — or permitted to actively request a postponement of the assessment. If delayed responses are permitted, then the target of reporting must be established as either "a recollection of the experience at the time of the missed signal or the experience at the (delayed) moment of recording" (Stone & Shiffman, 2002, p. 239).

Mappiness allows an ESM assessment to be completed in response to a signal at any time up to the receipt of the next signal. If participants do not hear a signal, they can nevertheless ascertain that a response is pending by the presence of a red badge on the Mappiness app's icon. The delay between signal and response is calculated and stored, so that maximum allowable delays may be applied as required during data analysis. Mappiness does encourage participants to respond quickly and consistently, however, and response statistics are displayed prominently on the app's

⁴We considered supporting more flexible specification of signalling hours — such as by providing separate settings for weekdays and weekends, or for every day of the week — but decided that the associated benefits would not justify the added complexity required for the user interface. Participants can still achieve an arbitrarily complex pattern of signalling hours by making alterations to these hours as necessary.

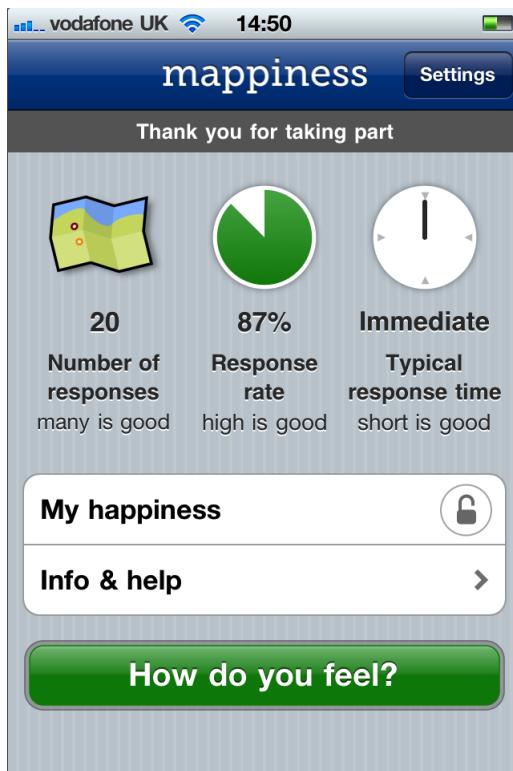


Figure 5.3: The Mappiness app main screen, showing response statistics

main screen. As illustrated in Figure 5.3, the following statistics are shown: total number of assessments completed; response rate (the number of signalled responses divided by the number of signals sent); and median (which is labelled as 'typical') response time.

The target of a Mappiness assessment is always the moment of recording, whether or not this is later than the moment of signalling. This policy is easiest for participants, and does not risk introducing elements of the recall bias that ESM is designed to eliminate. This policy is also the only one that is feasible, since the GPS location data, sound level and (where applicable) photograph will inevitably pertain to the moment of recording.

5.3.3.2 Suspension of signalling

Some ESM protocols enable participants to suspend signalling when signals would be embarrassing or inconvenient. As with other elements of the protocol, the decision to offer such a facility hinges on a trade-off between the convenience (and acceptability) of the protocol to participants and the integrity of the sampling scheme (Stone & Shiffman, 2002).

As described in subsection B.2.2, Mappiness signals are delivered by the Apple Push Notification Service, which conforms to the user's overall alert settings for his or her device. Mappiness signal sounds are delivered at the highest possible volume subject to the user's currently selected limit. If the user has silenced the device, Mappiness signals will also be silenced. If the user has opted for a vibrating alert in silenced and/or non-silenced mode, Mappiness signals will also vibrate in those modes. Of course, participants are also able to turn off their device, and in that case cannot receive signals.

Mappiness thus effectively offers temporary suspension of signalling alongside other device-wide settings. On the one hand, this restricts our control over signalling; on the other, it provides for the greatest consistency with participants' expectations, and is respectful of their existing preferences.

5.3.4 Volunteered assessments

Mappiness permits ESM assessments to be volunteered at any time. A volunteered assessment is defined as one completed when no assessment is pending: in other words, when the most recent

signal (if any) has already been responded to. As we inform participants, volunteered responses will not be included in our analyses. However, they still serve several purposes. First, participants may wish to record particular experiences for their own reference. Second, newly-registered participants may wish to explore the mechanics of the ESM response process immediately (and, in fact, a large majority do). Finally, participants are able to use a volunteered response to demonstrate the response process to friends and acquaintances who are interested in the study and may wish to take part themselves.

5.4 App implementation

The Mappiness system has two core elements: the iPhone app, and the data server with which installations of the app communicate. These were developed in tandem.

The basic data flow between the two elements is as follows:

1. the data server transmits a signal to a participant's app;
2. the participant responds via the app, while the app determines his or her location using GPS; and
3. the app transmits responses and location data back to data server.

A number of further elements provide additional features and greater robustness. The core and additional elements, and the data flows between them, are depicted schematically in [Figure 5.4](#).

The app was implemented in the Objective-C programming language with Apple's Cocoa Touch framework, using the iOS Software Development Kit 3 ([Apple Inc., 2010d](#)).

5.4.1 Interface and interaction design

"Designing user interfaces is a complex and highly creative process that blends intuition, experience, and careful consideration of numerous technical issues" ([Shneiderman, 1998](#), p. 89). Following Apple guidelines ([Apple Inc., 2011a](#)) and in accordance with our overall aims ([section 5.1](#)), we sought to make the interface simple, responsive, fluid and — ideally — enjoyable for app users.

We created alternative design mock-ups of key app screens, and assembled these into storyboards describing interaction flow⁵. We consulted a professional app developer at a London agency on these. An example storyboard is illustrated in [section B.11](#) on page 394 of Appendix B. We received several emails (and encountered a number of Twitter messages) complimenting the app's interaction design after launch.

5.4.1.1 Registration

When the app is first launched, the user is asked to complete three steps to sign up to participate in the study. The steps are listed in a suggested order and, as they are completed, ticked off the list, as illustrated in [Figure 5.5](#). The content of the three steps is illustrated in [Figure 5.6](#). Step 1 displays the consent form — the text of which is reproduced in full in [section B.8](#) on page 387 of Appendix B. The prospective participant may agree, or tap Cancel. Step 2 presents the registration survey described in [subsection 5.2.1](#). Step 3 asks the user to confirm (or modify) signalling settings, as outlined in [subsection 5.3.2](#). The user can also access more information about the study and the app — and contact us by email or using other contact details — via the 'Find out more' button on the main registration screen.

When all three steps have been completed, a button with the legend 'Sign me up!' is displayed. The user taps this button and waits as his or her information is transmitted to the data server. On completion, the registration screen peels away from the bottom right to reveal the registered main screen (shown in [Figure 5.3](#)).

⁵We used Apple's Interface Builder and The Omni Group's OmniGraffle Pro for this purpose.

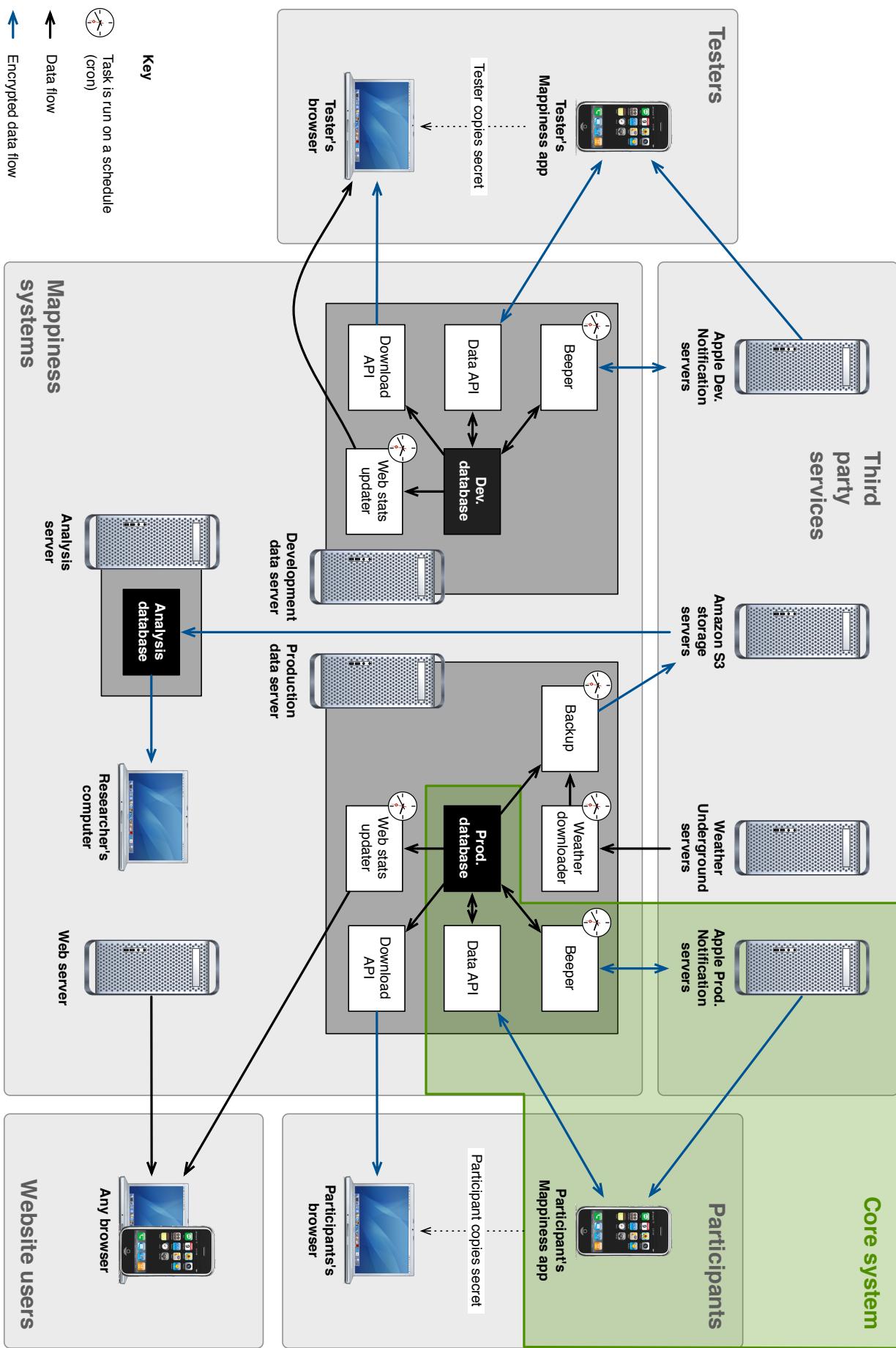


Figure 5.4: Mappiness infrastructure and data flow summary

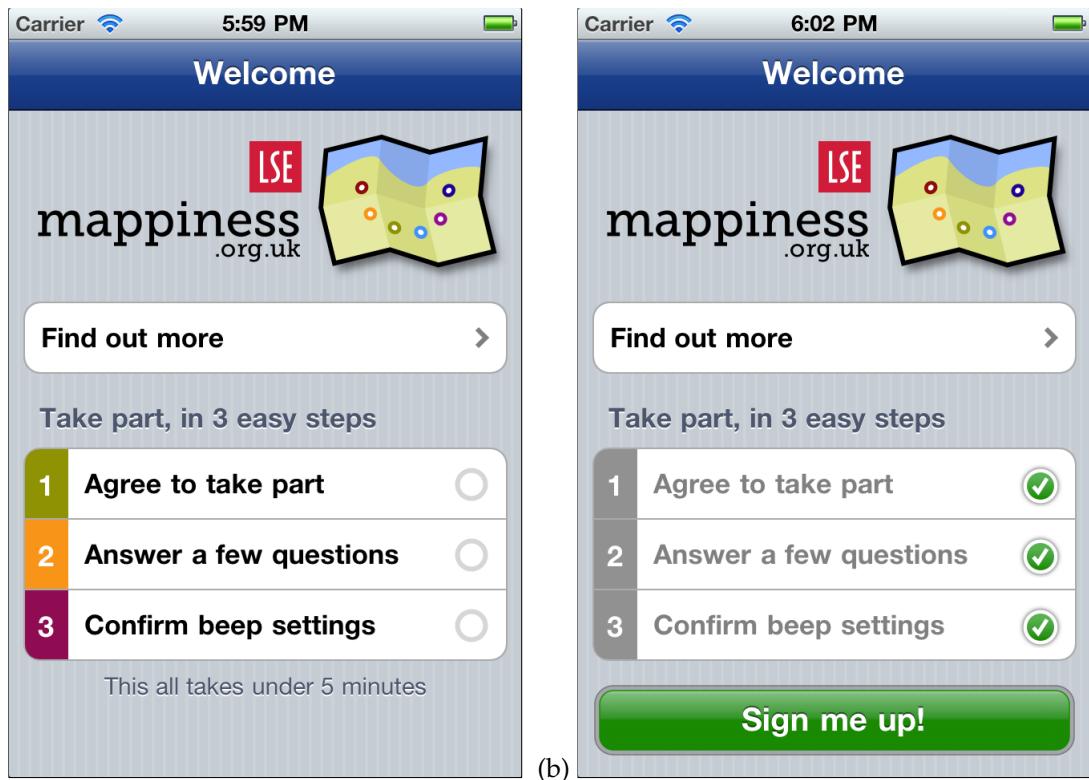


Figure 5.5: The app’s main screen (a) when first launched and (b) when all three registration tasks have been completed

5.4.1.2 Signals

Mappiness signals make use of the three features made available by the Apple Push Notification Service: each signal plays an alert sound, displays a textual message, and causes the number ‘1’ to be displayed on a red badge over the app’s icon to indicate that there is one ESM survey pending.

The alert sound is chosen by participants from a list within the app settings screen. The message reads: ‘**mappiness** — How do you feel? Please tell us as soon as you safely can’. If the device is unlocked, two associated buttons are displayed: ‘Close’ dismisses the notification, and ‘View’ launches the Mappiness app directly into ESM survey mode. If the device is locked, a slider is available to launch the app into ESM survey mode. The notification display is illustrated in Figure 5.7.

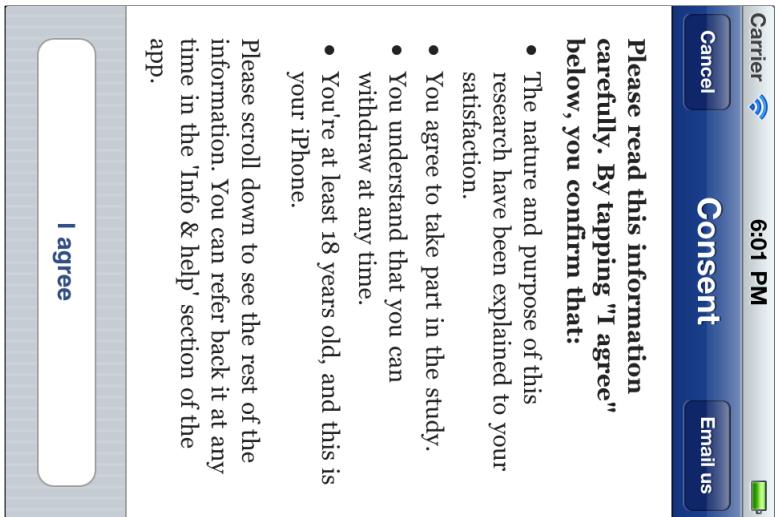
5.4.1.3 Surveys

Two types of surveys are conducted within the app: the one-off registration survey, and the repeated ESM assessment survey. The two share a common visual and interaction design, and are supported by the same generic survey interface implementation.

For speed, and to minimise context effects, the ESM survey appears immediately on app launch if an ESM assessment is pending. Also for speed, both surveys dismiss themselves automatically when the final question is answered. In each case, the first survey screen provides a ‘Cancel’ button that discontinues the survey, and subsequent screens each provide a ‘Back’ button to return to the preceding screen in case a response error has been made.

Omitted or inconsistent responses are prevented by selective disabling of certain response options. For example, in the Feelings item of the ESM survey, the *Next >* button is disabled until all three response scale sliders have been interacted with.

Survey completion may be interrupted if the participant exits the app or receives a telephone call on the device. If the ESM assessment survey is interrupted, answers up to the current point are saved, and are sent to the data server the next time the app is opened. Answers are not saved if the registration survey is interrupted.

(a) 

Carrier  **6:01 PM** 

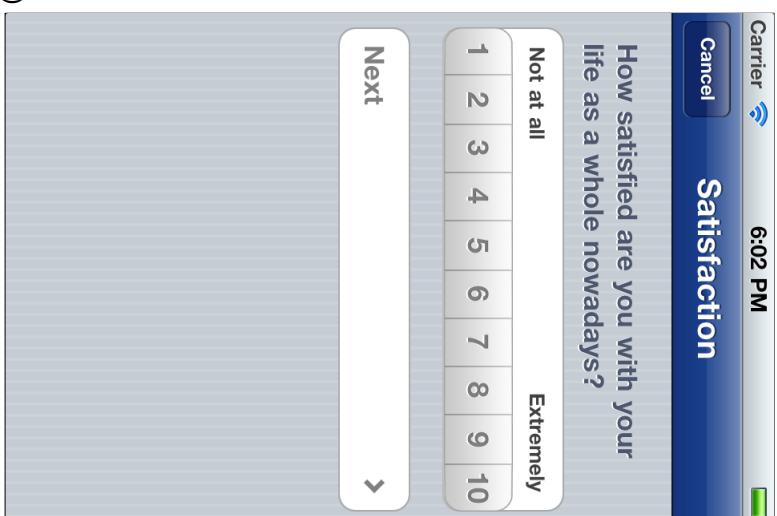
Consent

Please read this information carefully. By tapping "I agree" below, you confirm that:

- The nature and purpose of this research have been explained to your satisfaction.
- You agree to take part in the study.
- You understand that you can withdraw at any time.
- You're at least 18 years old, and this is your iPhone.

Please scroll down to see the rest of the information. You can refer back it at any time in the 'Info & help' section of the app.

I agree

(b) 

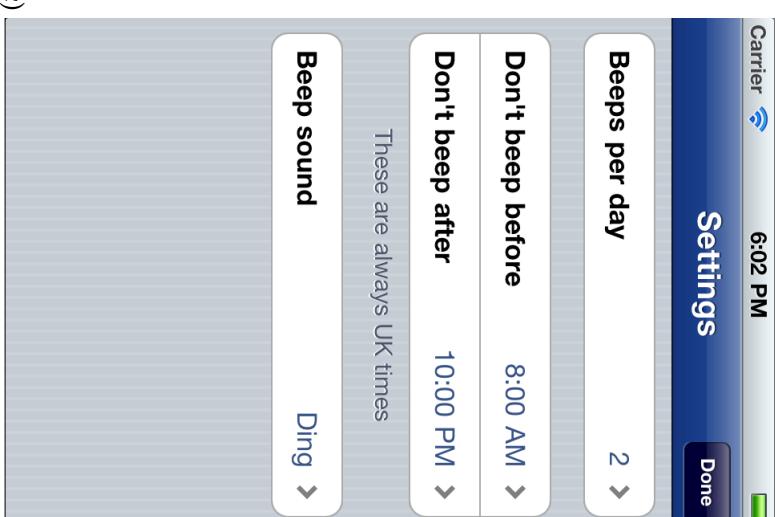
Carrier  **6:02 PM** 

Satisfaction

How satisfied are you with your life as a whole nowadays?

Not at all	Extremely								
1	2	3	4	5	6	7	8	9	10

Next

(c) 

Carrier  **6:02 PM** 

Settings

Beeps per day 2 >

Don't beep before 8:00 AM >

Don't beep after 10:00 PM >

These are always UK times

Beep sound Ding >

Figure 5.6: The three registration tasks: (a) providing informed consent, (b) completing the registration survey (first screen), and (c) confirming beep settings.



Figure 5.7: Mappiness APNS notification display when device is (a) unlocked or (b) locked

Both surveys are implemented using standard Cocoa Touch interface controls, which are professionally designed and familiar to iPhone users. Different questions use different control types, often in combination.

'Choose one' items Most multiple choice items with a single answer, such as the gender item in the registration survey, use table view cells with the chevron-shaped 'disclosure' indicator. When a participant taps a cell, their response is registered and the survey immediately proceeds to the next screen. Table view cells present a large tap target for the participant, and the disclosure indicator elicits the correct expectation that tapping will cause the survey to advance. A table view cell with disclosure indicator is also used to present the participant with a *Next >* or *Skip >* option following other interactions on a survey screen.

For the year of birth registration survey item, the picker control is used instead. The picker control shows response options on a rotating wheel, and is better suited to the display of a large number of response options. We set the initial position of the picker to 1975: we expect this to be around the middle of the response range, and this minimises the distance participants will need to scroll. There is however a risk that some participants will leave the the picker in this position to advance most quickly.

These 'choose one' controls are illustrated in Figure 5.8.

'Tick all that apply' items Multiple choice items accepting multiple answers, such as the activities item in the ESM survey, use table view cells that, when selected, show the 'checkmark' indicator and render their text in blue. These items show a 'Tick all that apply' instruction to participants at the top of the screen.

These table view cells are illustrated in Figure 5.9.

Scale items The life satisfaction item in the registration survey is answered on an ordinal scale with labelled endpoints: for compactness, and for greatest similarity with such scales in other survey media, this item is implemented using a segmented control.

The feelings items in the ESM assessment survey are answered on visual analog scales, and these are implemented using slider controls. We replaced the standard circular slider 'thumb' with a



Figure 5.8: 'Choose one' survey item controls: (a) table view cells with disclosure indicator and (b) picker



Figure 5.9: 'Tick all that apply' survey item controls: table view cells with checkmarks

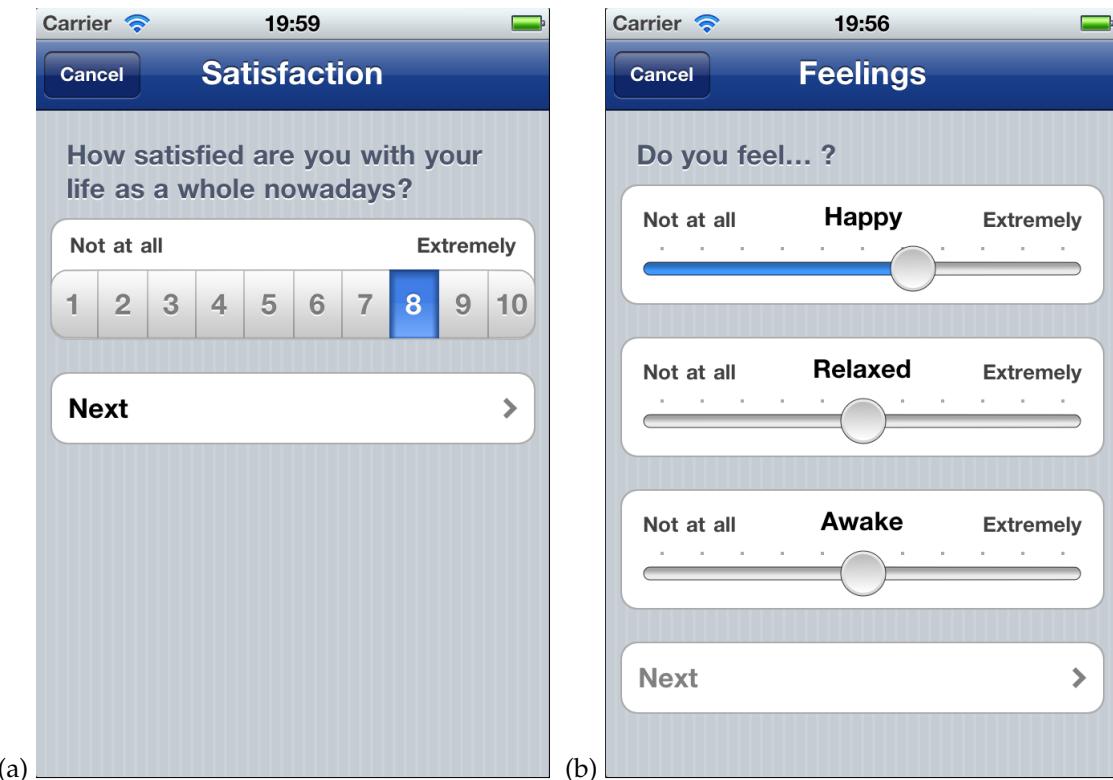


Figure 5.10: Scale survey item controls: (a) segmented control and (b) sliders

similar but larger version, to provide a larger and therefore easier target for interaction. As a result of feedback from piloting, we also added tick marks along the top edge of the slider to help participants judge the slider position. The slider thumb starts in the middle position, but the slider track appears in grey until the thumb has been tapped or moved, to indicate that this is not a selected position. While the default positioning of the slider thumb may lead to anchoring effects, this appears unavoidable.

These scale controls are illustrated in Figure 5.10.

5.4.1.4 Settings

The settings screen is displayed in two forms. It is displayed during the registration process, when for simplicity it offers only signalling settings, as seen in Figure 5.6 (c). It is also accessible via a button on the main screen, in which case settings regarding prompting for and saving photos during ESM assessments are also offered, as shown in Figure 5.11. The design of the settings screens is modelled on the settings app provided by Apple. The summary screen shows all current settings, while tapping any setting displays a screen on which that setting may be changed. All second-level settings screens use table view cells with a checkmark indicating the current selection, except the time settings, which are selected using pickers.

5.4.1.5 Information and help

Prior to registration, a *Find out more >* button is provided; after registration, an *Info & help >* button links to the same information. A single paragraph summary of the Mappiness project is given, as illustrated in Figure 5.12 (a), with links to three further sections. The 'Key information' section reproduces the content of the consent form. The 'FAQs' section provides additional detail in a question-and-answer format, which is shown in full in section B.9 on page 388 of Appendix B. The 'Acknowledgments' section contains thanks and acknowledgments. App users can send us an email — with useful information for troubleshooting included automatically — via the *Email us* button available on every information page, which displays the screen seen in Figure 5.12 (b).

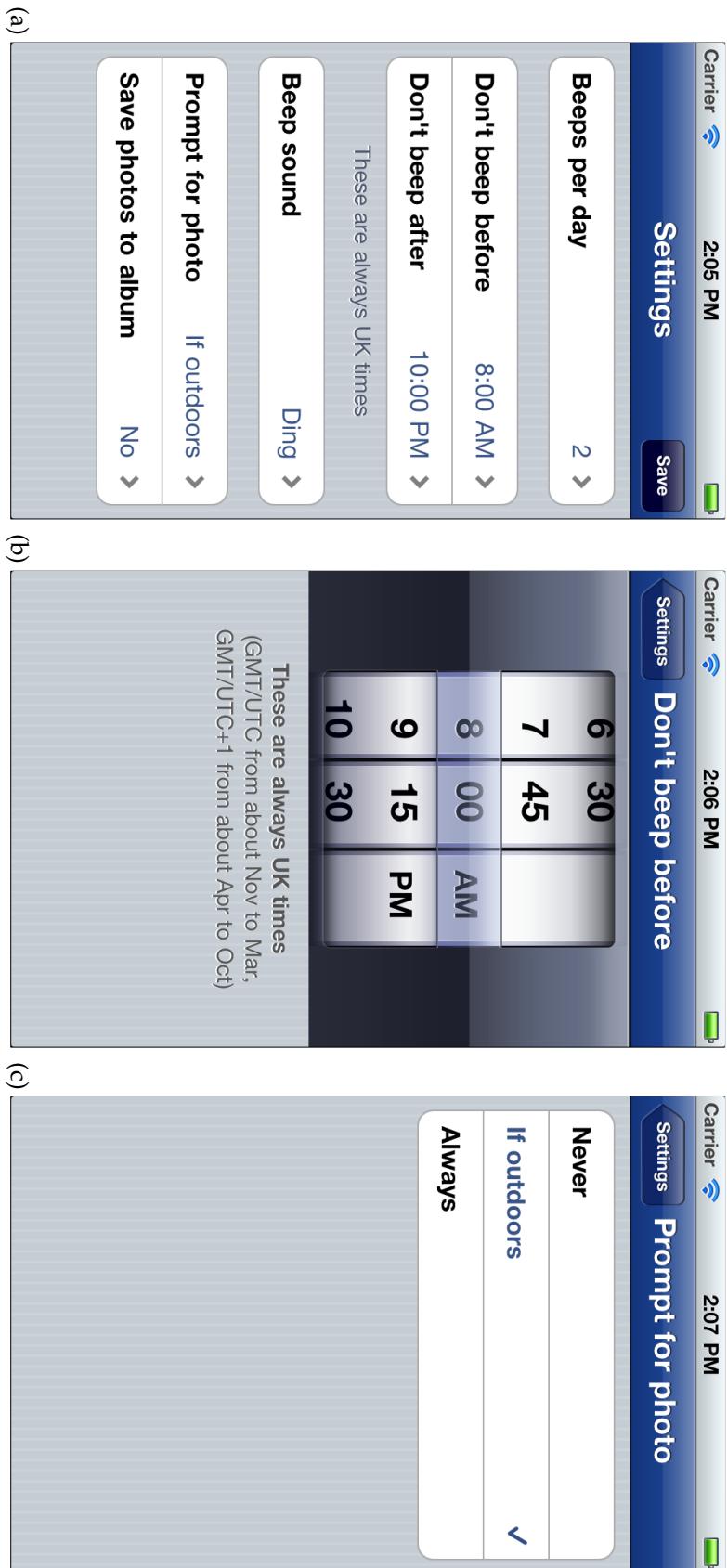


Figure 5.11: Settings screens after registration: (a) the summary screen, (b) the *Don't beep before* second-level screen, which uses a time picker control, and (c) the *Prompt for photo* second-level screen, using table view cells with a checkmark.

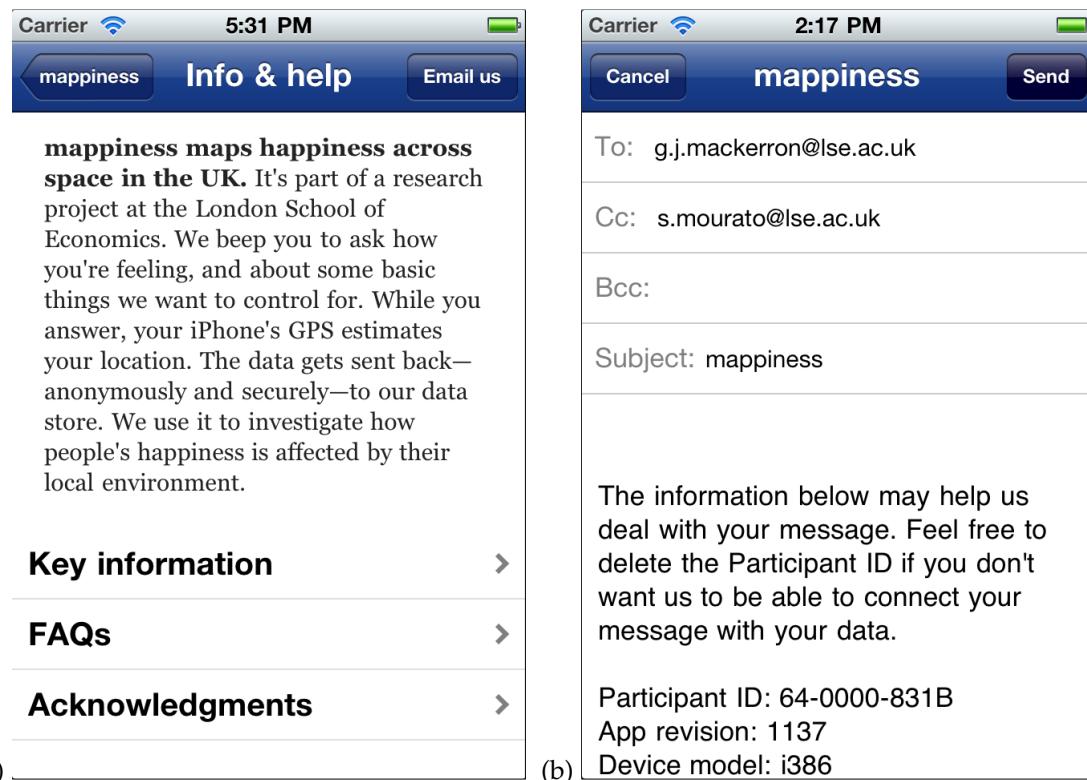


Figure 5.12: *Info & help* screens: (a) the index screen and (b) the *Email us* screen accessible from it

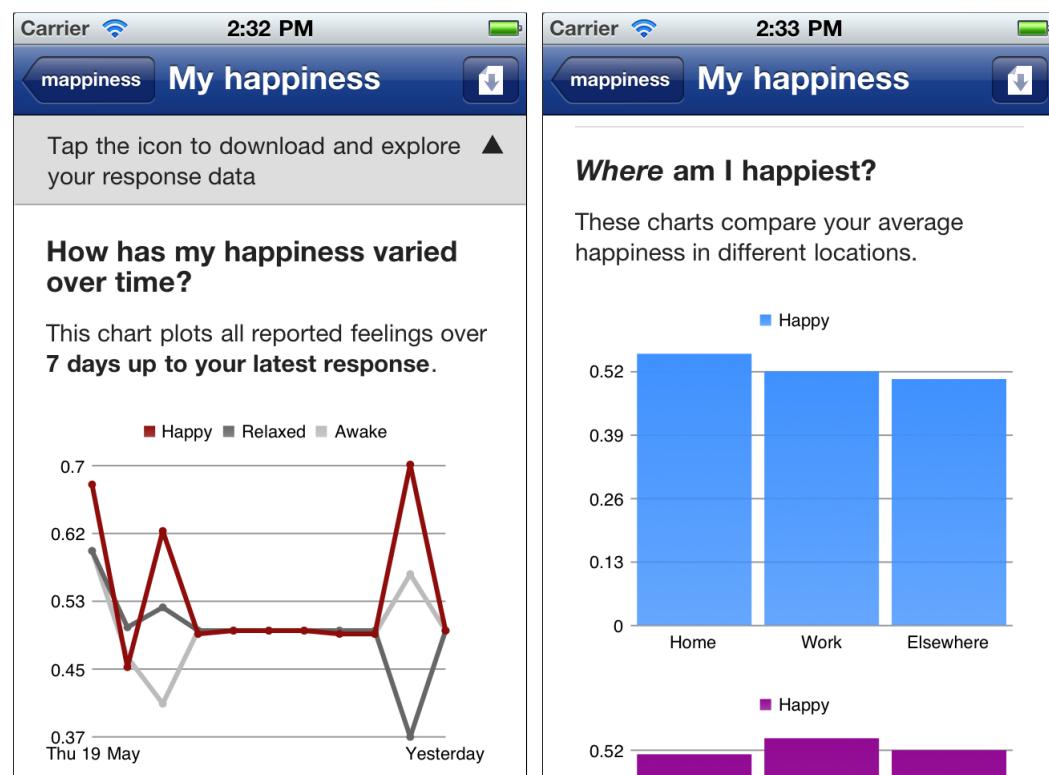


Figure 5.13: *My happiness* charts screen in two scroll positions

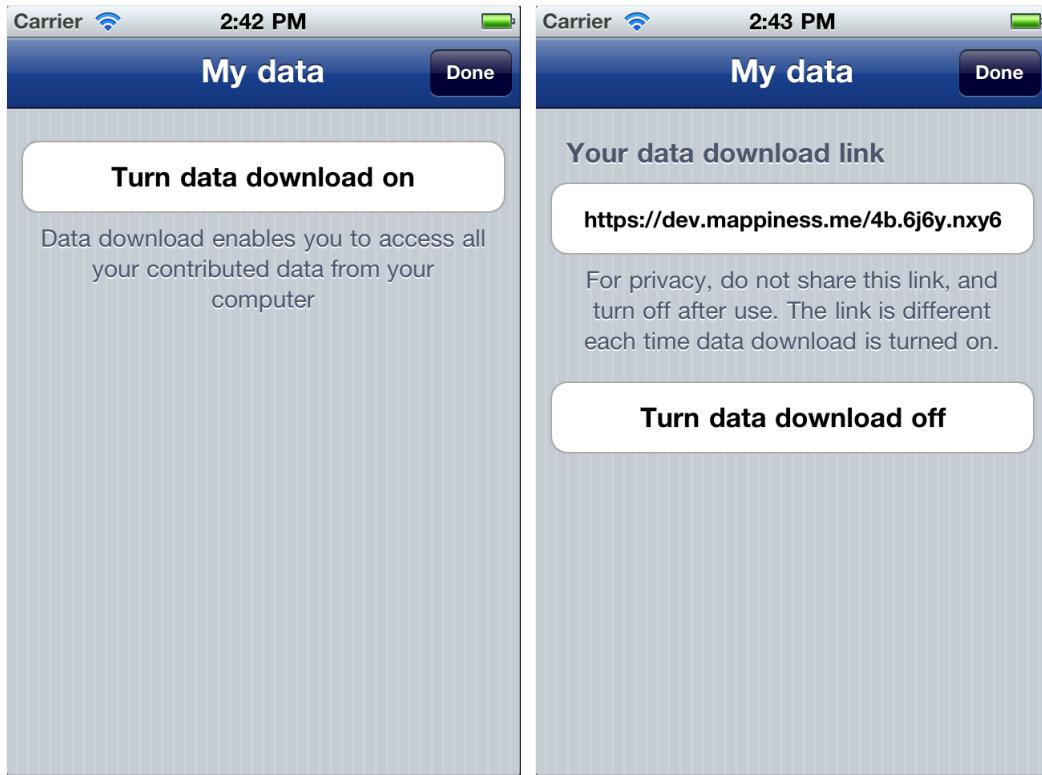


Figure 5.14: *My data* screen

mappiness data download

<https://dev.mappiness.me/4b.6j6y.nxy6>

mappiness.org.uk

Data download

explore

download

map

Explore your responses on an interactive map

charts

View, save and print the same charts you get in the app

gallery

See all the photos you've contributed

map - kmz

Download and view your responses using a mapping application like [Google Earth](#)

calendar - ics

Trace your responses through time in a calendar application like Google Calendar, iCal or Outlook.
In some applications you can subscribe to this calendar link and new responses will appear automatically:
<https://dev.mappiness.me/4b.6j6y.nxy6/mappiness.ics>

raw data - xls

Analyze your raw data in Excel or similar

raw data - csv

Import and analyze your raw data in all kinds of number-crunching applications

raw data - json

Geeks: load data into your programming language of choice (see API section below)

Figure 5.15: Private data download page linked from *My data* screen

5.4.1.6 Charts and data

The *My happiness* button on the main screen displays a set of charts and statistics about the participant's own responses, which are calculated on request by the data server. These are illustrated in [Figure 5.13](#) and a full example set is reproduced in [section B.10](#) on page 389 of [Appendix B](#). A button at the top right of the *My happiness* screen provides access to the *My data* screen. From here, the data download capability can be turned on or off, as illustrated in [Figure 5.14](#). When data download is turned on, the participant can access their data in a range of formats from their web browser, as shown in [Figure 5.15](#). For privacy, the *My happiness* and *My data* screens can be protected by a four-digit passcode. The passcode is managed by tapping the padlock icon within the *My happiness* button on the main app screen.

5.4.2 ESM assessment data

In addition to the data obtained by survey during an ESM assessment, other data is collected using the capabilities of the participant's iPhone and the data server.

5.4.2.1 Time and date

The moment of signalling is recorded by the data server. This will not be precisely the same moment that the signal is delivered to the participant's device, but in practice it will usually be close.

The moment that the participant began responding is reported by the app. For this we are reliant on the accuracy of the clock setting on the participant's iPhone. In general, this should not present a problem, since the device defaults to automatic synchronisation of the clock with the network provider. The app also reports the time taken to complete the response.

5.4.2.2 Location

The device's Assisted Global Positioning System (A-GPS) subsystem is activated at the beginning of the ESM assessment process, and the device location is queried at the end, to allow the longest possible time for an accurate location fix to be achieved⁶.

If the participant is indoors — with no line-of-sight to GPS satellites — the device will calculate location by triangulation of known wireless Internet (WiFi) access points and mobile telephony base-stations. In this situation, accuracy will vary considerably depending on proximity to such known locations, and in the worst case no location data will be available. However, the estimated accuracy of the calculated location is reported by the device in all cases, reducing the risk that inaccurate location data will bias our analyses.

If the participant is outdoors, a more accurate location estimate should be available using GPS. Therefore, as discussed in [5.2.2.2](#), if the participant has indicated in the ESM survey that he or she is outdoors, we check before completing the survey that the estimated location accuracy is $+/- 100\text{m}$ or better. If it is not, we wait for up to 60 seconds for a better estimate.

The specifications of the GPS receiver in the iPhone are not published, although it is known that later models have improved hardware. The meaning of the reported accuracy bounds — such as " $+/- 100\text{m}$ " — is also not stated (is it, for example, a 95% confidence interval?). The nature of the error in location estimates is therefore not known with certainty. However, everyday use of the device for other purposes indicates that the true location is almost invariably within the reported accuracy bounds of the reported estimate.

5.4.2.3 Sound level

The device's microphone is also activated at the start of the ESM assessment process, and the detected noise level is queried every quarter-second for five seconds, providing 20 readings⁷.

⁶We use the iPhone's Core Location framework ([Apple Inc., 2010b](#)) to query the device's location.

⁷We use the open-source SCLListener library (http://github.com/stephencelis/sc_listener/), which provides an interface to the iPhone's Core Audio services.

Table 5.1: App updates

Version	Availability date	Changes
1.0	6 August 2010	Initial release.
1.0.1	19 August 2010	Fixed a bug where timezones did not match in summary settings and time selection screens.
1.0.2	25 September 2010	Added five new activities, and settings regarding photos (when to prompt and whether to save to album).
1.1	23 May 2011	Added the data download feature, text notes in responses, and optional passcode for access to <i>My happiness</i> and <i>My data</i> screens.
1.1.1	1 June 2011	Fixed a bug causing occasional crashes on passcode screens.
1.1.2	6 August 2011	Fixed minor compatibility issues for forthcoming iOS 5 update.

Sound level readings are returned on a logarithmic scale, between -160 (no sound detectable by the microphone) and 0 (loudest sound measurable by the microphone) (Apple Inc., 2010a). The specifications of the iPhone's microphone are, again, not published, and may vary between device models. The microphone is likely to be directional, so detected noise levels may depend substantially on the orientation of the device relative to the sources of noise. If the participant is listening to music (or other audio) using the device, the sound level is not measured⁸.

5.4.2.4 Photo

The participant is prompted to take a photo during the ESM assessment as discussed in 5.2.2.2. The camera interface is provided by the iPhone software⁹, to which we add an overlay displaying instructions. Once a photo has been taken, we resize it to much smaller dimensions — 320×240 pixels — and obtain a compressed (JPEG) representation for speedy transmission over the network.

Different iPhone models have different camera hardware: some later models offer higher resolutions, auto-focus, better performance in low light levels, and LED illumination. Unfortunately, it is not possible to retrieve metadata from the photo, so no indication of light level (via exposure settings) or of the use of the LED is available. The iPhone also has a light sensor, which is used to vary the screen brightness in response to background conditions. Unfortunately this sensor's output is also inaccessible to application code.

5.4.2.5 iPhone model

The iPhone model (original, 3G, 3GS or 4) is recorded automatically, so that any variation in GPS, microphone and camera characteristics can be accounted for in future research.

5.4.3 Updates

Some features described above were added after launch, and some bugs were fixed, by the provision of app updates through the App Store. The content of these updates is summarised in Table 5.1. Elsewhere in this chapter we refer to version 1.1.2, including all updates, unless otherwise stated.

⁸Measuring the sound level in this situation would interrupt the participant's listening. In addition, the external sound level is arguably not relevant if the participant is using headphones.

⁹We use the iPhone's UIImagePickerController interface (Apple Inc., 2011b).

5.5 Data server implementation

Two separate data servers were deployed: the production and development servers. The production server communicates with the live app, and should be operational and available at all times. The development server is used for development and testing of the Mappiness software. It also serves as a ‘guinea pig’ system for configuration changes, and for updates to the operating system and other supporting software.

Each server is a VPS¹⁰ hosted by Linode, LLC in their London data centre. The servers run the Ubuntu Linux operating system and a range of other open-source software packages. All original Mappiness software running on the data servers is written in Ruby, a dynamic, open source programming language (Flanagan & Matsumoto, 2008).

The data server was designed to run itself with no routine intervention, but was subject to ongoing monitoring. During the first few weeks a number of minor bugs that had not been uncovered during testing were fixed. In addition, the data server was upgraded, and optimisations were made to the code, database schema and server configuration, in order to deal with the unexpectedly large number of participants. The data server software was also subject to periodic updates to enhance the charts and other information provided on the *My happiness* screen.

Further information on the implementation of the data server is provided in section B.2 of Appendix B on page 362.

5.6 Testing and piloting

We engaged nine volunteers to test the app for one week¹¹. Testers were asked to comment on the reliability and stability of the app’s implementation, the usability and aesthetics of the user interface, and the clarity and style of explanatory text. The testing phase also served as the pilot for the registration and ESM assessment surveys, and testers were asked debriefing questions in relation to their experiences of completing these surveys.

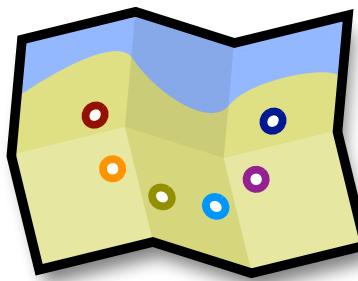
Based on testers’ feedback the following changes were made:

- Number the registration steps from 1 – 3, to provide an obvious flow through the registration process (the steps may still be completed in any order desired).
- Stop showing a *Cancel* button at the top right of each screen in the surveys. One tester expected a button in this position to advance the survey. This change also simplifies the interface. (Surveys can still be cancelled by repeatedly tapping the back button to return to the first screen, then tapping *Cancel*).
- Prevent the ESM assessment survey from stopping any music that is playing on the device. We do this by checking that music is not playing before attempting to measure sound levels.
- Draw evenly-spaced tick marks alongside the ESM assessment feelings item sliders. Several testers requested this because they were concerned that their answers were inconsistent.
- Add ‘Clients, customers’ to the list of options in the ESM assessment companionship item.
- Add ‘Waiting, queueing’ and ‘Hobbies, arts, crafts’ to the ESM assessment activities item options.

Descriptions provided elsewhere in this chapter incorporate these changes.

¹⁰A VPS is a Virtual Private Server: a virtual machine that runs in software alongside other virtual machines on a single physical computer. It is functionally equivalent to and has the privacy of a separate physical computer — it runs its own full-fledged operating system and can be independently rebooted — but is generally cheaper to operate.

¹¹Testers were provided with the app prior to release in the App Store using Apple’s Ad Hoc distribution method.



mappiness
.org.uk

Figure 5.16: The Mappiness logo

5.7 Participant recruitment and communication

5.7.1 Participant motivation

Recruitment of participants to the study was opportunistic. We hoped that potential participants would be attracted by three main factors:¹²

- intrinsic motivation, based on an interest in or enjoyment of the tasks associated with participation (this motivation could be intensified by the study's novelty and use of new technology);
- altruistic motivation, through assisting research aimed at producing knowledge that may ultimately be of social benefit; and
- direct personal benefit, in the form of the opportunity for participants to learn more about variations in their own wellbeing, and by the somewhat game-like nature of participation, in which response occasions, rates and times can be tracked and (potentially) compared.

We considered whether financial incentives might be provided, but ruled these out on two grounds: they would become prohibitively costly if a sample of the desired large size was achieved, and they could risk crowding out intrinsic and altruistic motivations (e.g. Frey & Jegen, 2001).

To reach potential participants, we intended to rely on word-of-mouth and on coverage in traditional and social media. Word-of-mouth recruitment would be aided by the fact that the app signals participants at random moments, potentially in social contexts where the signal might be remarked upon and then explained.

As noted below, we were also greatly assisted by a period of 'featured' positioning in the App Store.

5.7.2 Communication

Communication with prospective and actual participants was carried through multiple channels. We attempted to achieve an appealing and consistent visual identity or brand across media, with the use of a distinctive logo, colour palette and fonts. The logo is illustrated in Figure 5.16. It includes the London School of Economics logo within it, to help emphasise that the study is part of a non-commercial, academic research programme. The clean design and relatively informal copywriting style were inspired by those of various successful apps and online services.

¹²These factors are discussed by, for example, Cavusgil & Elvey-Kirk (1998).

5.7.2.1 Website

We created a public website at <http://www.mappiness.org.uk/> (with a custom shortcut URL, <http://mappin.es/>) to provide information about the study — and about current UK and London happiness conditions — to those who might be interested, including prospective participants and journalists.

The full content of the website is reproduced in section B.6 on page 369 of Appendix B. In brief, it consists of five pages:

Home provides a brief introduction, shows five screenshots from the app (selected using numbered controls), and ends with a 'call to action' in the form of two prominent links. The 'get the app' link takes visitors who are browsing on their iPhone directly to the App Store, and instructs those on other platforms to search the App Store for 'mappiness' (which is the quickest way to download the app). The 'tell me more' link takes visitors to the More info page.

News displays up-to-date results of a Twitter search for 'mappiness' (to convey the buzz of social communication surrounding the study), showcases our TEDx talk (see below), and lists TV, radio, press and blog coverage with links and key quotes.

Meters shows mean happiness levels in graphical form using 'hedonimeters' and an accompanying chart. Happiness levels are calculated by the data server as discussed in subsection B.2.5.

Maps shows the most recent happy responses that include photos on an interactive map of the UK. Again, this display is backed by data server calculations.

More info provides background to the research, gives our contact details, answers various practical questions, and acknowledges those who have helped with the study.

Each page also includes:

- a link to the App Store, using an Apple-supplied emblem, at top right;
- a participant count, updated every five minutes, at the bottom;
- four links, also at the bottom, to facilitate sharing the page to the social networking and news sites Twitter, Facebook, Digg and Reddit (in the first nine months of the study, pages were shared on Facebook by more than 1,500 visitors); and
- a red 'Feedback' tab at the left-hand side, which links to the feedback forum (see subsubsection 5.7.2.7).

The website was designed to handle extremely high loads, in case of major media coverage, with all static assets served by an external Content Delivery Network (CDN) and all dynamic elements served from a periodically-refreshed cache. The website received over 70,000 visits in the first nine months of operation. These visits are charted week-by-week, and broken down by source, in section B.7 on page 382 of Appendix B.

5.7.2.2 Traditional media

At launch we distributed a press release, primarily to technology journalists at large media organisations. The full text of the release is reproduced in section B.4 on page 368 of Appendix B. We also made press resources available via an unadvertised link on the website¹³, including print quality versions of our logo, screenshots from the app, and 'hedonimeter' artwork. We gave a number of interviews in response to media enquiries, and received significant national and international coverage.

All major coverage is listed on the News page of the website (see section B.6 on page 369 of Appendix B). It included:

¹³<http://www.mappiness.org.uk/press/>

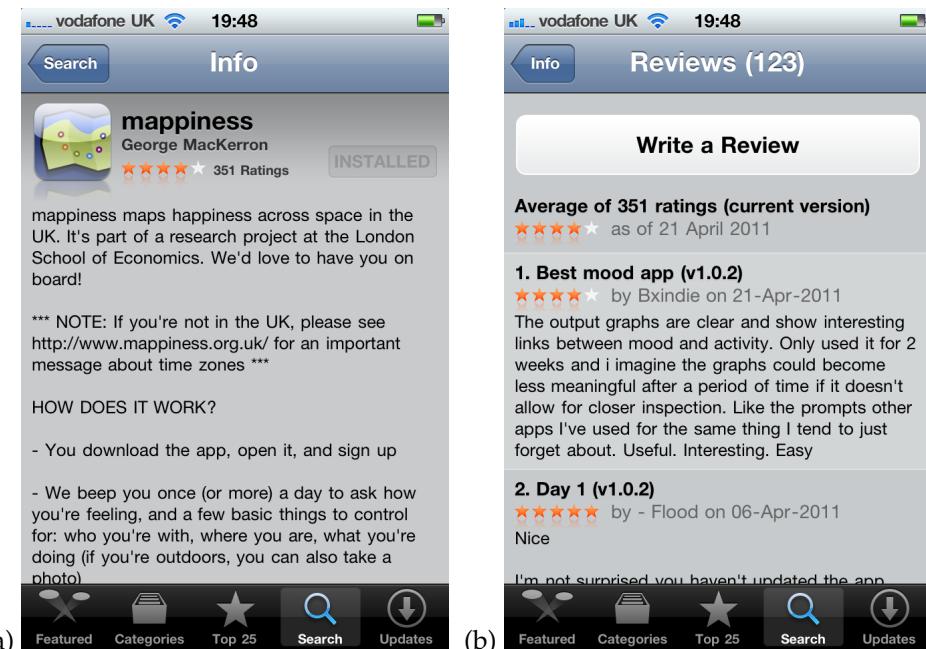


Figure 5.17: (a) Representation and (b) reviews in the App Store

- TV packages on BBC One, BBC News Channel and BBC World News (*Click* programme), CNN International (*Connect the World* programme), and Reuters TV (syndicated by BBC Mundo, US regional broadcasters, and others);
- interviews on BBC Radio 2, 4, 5 Live, World Service and local radio stations, and on NPR and regional stations in the US; and
- stories on the front page of Le Figaro and in the Independent (in their '50 Best Apps'), the Independent on Sunday, the Observer, the Sunday Times, the Telegraph, and the Wall Street Journal.

5.7.2.3 Blogs and social media

We set up a blog to maintain communication with participants and other interested parties, at <http://blog.mappiness.org.uk/>. We used this to post a number of news items and interim analyses. We also registered a Twitter account — @mappiness_app — and posted messages there from time to time.

Others' blogs and Twitter streams also carried information about the research study. Thousands of Twitter messages about the project were sent, and we believe these were a significant recruitment source.

5.7.2.4 Presentations

We were invited to speak at the Sustainable Development Research Network (SDRN) annual conference and at TEDx Brighton, a local event dedicated to 'ideas worth spreading'. A 16-minute video of the TEDx talk was produced, which we featured on the website as providing a useful introduction to the research.

5.7.2.5 App Store

All participants must download the app via the App Store. Figure 5.17 (a) illustrates the app's presence in the Store, while the full text of the description given is reproduced in section B.5 on page 369 of Appendix B. The app is filed under the Store's 'Lifestyle' category but, given the large number of apps in each category, is more likely to be reached by a direct search.

Mappiness was also displayed in the editorially-driven 'Featured' area of the UK App Store for two weeks shortly after launch, and we believe this was the source of a large proportion of the large number of downloads during this period. We had contacted a developer Partnership Manager at Apple UK to make the case for such placement.

Reviews App users are able to post reviews (free text) and ratings (1 – 5 stars) of apps in the Store. For Mappiness, these may influence potential participants' choice to download and take part. In iOS 3, the user is prompted to rate an app when it is deleted, and this can cause a downward bias in app ratings. To help counter this, we displayed a message to ongoing users, requesting them to give a rating: when participants completed exactly ten ESM assessment responses, the message displayed at the top of the main screen of the app changed temporarily to 'Like mappiness? Please rate us in the App Store'. The app was rated at 4 out of 5 stars throughout most of the research period.

5.7.2.6 App

As just noted, the main screen of the app displays a one-line status message which is retrieved from the server, alongside current response statistics, each time the app is launched. This message is used for brief ongoing communication with participants.

Before any ESM assessments have been submitted this message reads 'If not in UK, see our site for timezone info', to try to prevent non-UK participants from being caught out by timezone differences. When exactly ten responses have been submitted, it requests an App Store review, as noted in [subsubsection 5.7.2.5](#). At all other times, it displays a default message. Most commonly, we set this to 'Thank you for taking part', but we occasionally varied it with news about the study: for example, a note that we were on Twitter, or about media coverage, or a link to a new post on the blog.

Prospective and registered participants can also contact us by email directly within the app, as noted in [subsubsection 5.4.1.5](#). More than 600 emails were received by this means in the first nine months of the study.

5.7.2.7 Feedback forum

We provided a feedback forum to enable participants and others to contribute and vote on ideas for the project, available at <http://mappiness.uservoice.com/>. During the nine months after launch, more than 50 ideas were contributed. The top five were:

1. Add an Android version of the app (94 votes)
2. Plot on the map where users report feeling unhappy (52 votes)
3. Make it global! (46 votes)
4. Add the ability to export your personal data (41 votes)
5. Add more "Activities" (22 votes)

We have acted on ideas 4 and 5.

5.7.3 Recruitment and response trends

The app was approved by Apple and became available in the App Store on 6 August 2010, and was officially launched ten days later. Rates of participant recruitment during the period up to May 2011 are illustrated in [Figure 5.18](#), which shows weekly website visits, app downloads, and registrations within the app. As expected, the three quantities are in general highly correlated, with spikes that can be traced to items of media coverage. The first and largest spike also coincides with being featured in the UK App Store for two weeks — it is thus largely UK-specific, and unusually weakly correlated with website visits.

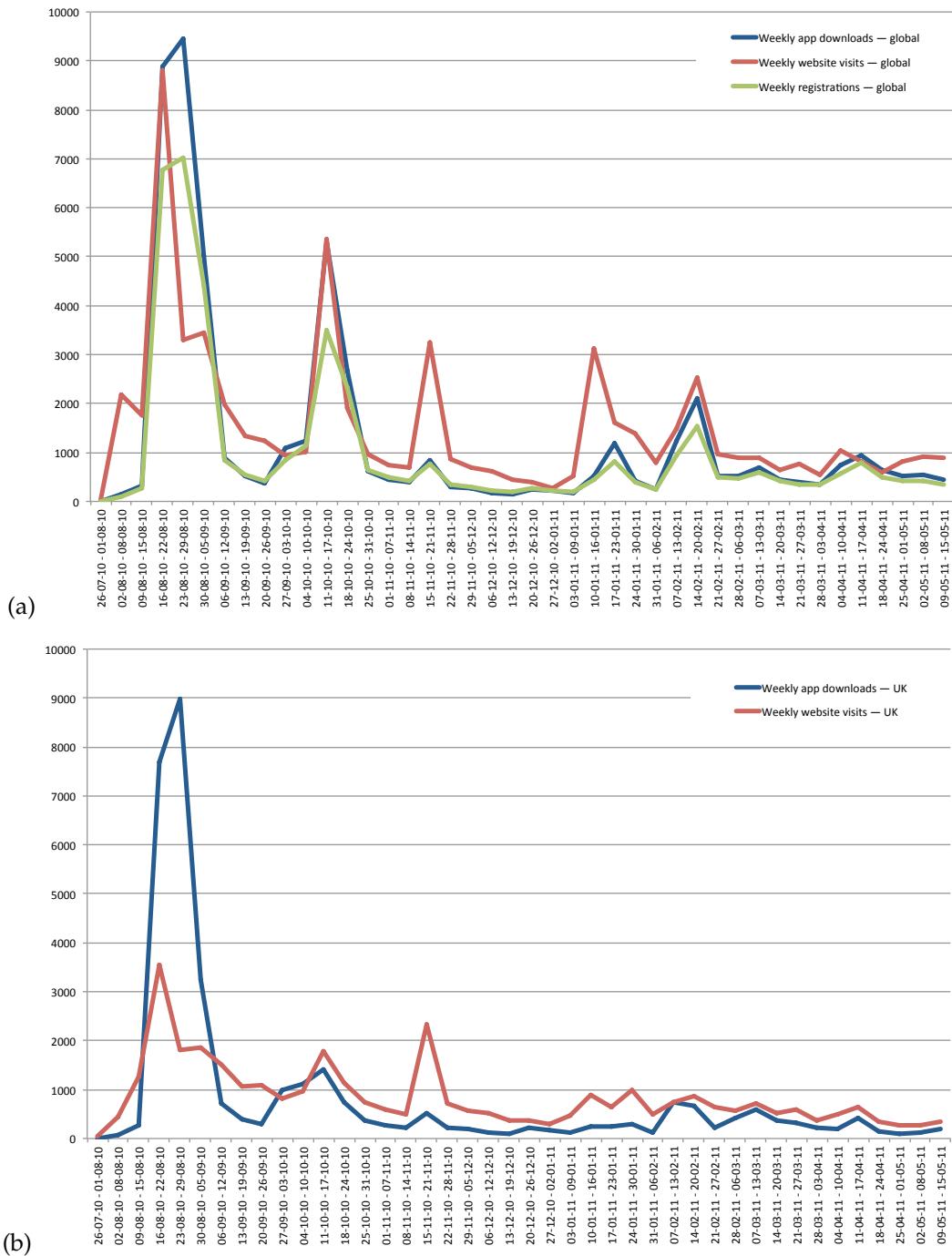


Figure 5.18: Recruitment statistics: weekly website visits, app downloads and participant registrations, (a) globally and (b) from the UK only (UK registrations cannot be shown, because registrations are not geographically located)

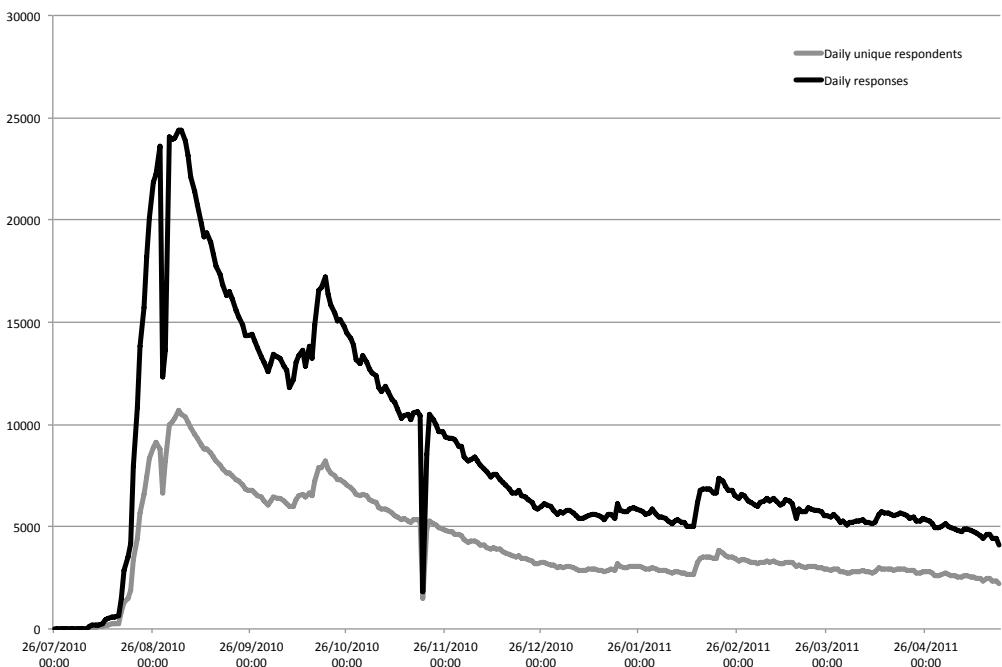


Figure 5.19: Global response statistics: daily response and responding participant counts

Daily response counts are illustrated in Figure 5.19. Changes in these counts reflect a balance between the recruitment of new participants and the loss of existing participants (as well as any trends in response rate across individuals' participation periods). As expected, therefore, numbers of responses and of responding participants increase during periods of major recruitment, as seen in Figure 5.18, and fall during other periods. Two brief troughs in the response count chart — from 28 – 30 August and on 19 November — are associated with temporary server failures, during which participants were not signalled.

5.8 Data quality and cleaning

In comparison to the checks run on the web survey data, which were discussed in section 4.6, relatively little quality checking was applied to the ESM data. There are three main reasons for this.

First, ESM study participants are not paid, and have no obvious incentives to supply poor quality or inaccurate responses. In fact, doing so would invalidate two of the three incentives for participation discussed in subsection 5.7.1. Second, location information is sensed automatically, and cannot therefore be easily falsified. We therefore do not need to verify location using IP addresses, for example. Third, there is rather less scope than in the web survey data for quality checking — there are relatively few response combinations which are impossible, even if some may seem improbable.

The checks which we do run are discussed in relation to broader issues of response validity in section 8.1.

5.9 Summary

In this chapter we have discussed the design and implementation of our spatial ESM data collection technique. We developed an app for iPhones (and other Apple iOS devices), and data server software to signal to and receive data back from it. We prioritised speed and simplicity in the app-based ESM assessments, to facilitate recruitment and retention of volunteers. We collected a range of data using survey items and the devices' sensors, not all of which can be analysed within the scope of this thesis.

As already stated, the data collected by this means enables us to examine links between EQ and SWB at the highest spatial and temporal resolution. And as we discuss further in the final chapter, we believe this methodology to have significant potential for further exploitation, in this and many other fields.

Chapter 6

Data analysis methods

The previous two chapters detailed our collection of original survey data — conventional and ESM — to inform analyses of EQ and its relations to happiness.

Responses from the London survey have one or two associated point locations: the indicated map locations of the respondent's home and, if applicable, workplace. Responses from the UK survey include one or two full postcodes: again, those of the respondent's home and, sometimes, workplace. And each ESM study response has associated point coordinates: the GPS-derived response location. In all three cases, we use the available location information to augment the response variables with information from environmental and other spatial data sets.

In the first part of this chapter we describe those external data sources and the methods by which we have joined them to our primary data. Some of the methods and most of the data have not previously been applied in the happiness economics literature on EQ. In the chapter's brief second section we outline the simple OLS and fixed effects models which we employ in the analysis of this primary and secondary data.

6.1 Spatial methods

Spatial data was processed within a PostgreSQL relational database system with PostGIS spatial extensions — as also used for the ESM data collection — using SQL commands. For some tasks we also made use of the PostgreSQL procedural language PL/pgSQL¹ and the PL/R² bindings to the R programming language (R Development Core Team, 2011). In order to handle the large volume of data collected in the ESM study, a dedicated server was built and optimised for the database system. Data were visualised, and diagrams were produced, using the open-source application QGIS³ and Google Earth⁴.

6.1.1 Data sources

Spatial data may be supplied in three forms. Raster formats represent data using a grid, where each grid cell or pixel has an associated value or values. Vector formats represent data as points, lines or polygons defined by geographical coordinates, which may each have an associated value or values. Geocoded data provide values associated with geographically-specific codes, such as postcodes or ward identifiers. They may be joined with other geocoded data, or converted to vector data, by the use of appropriate lookup tables.

The spatial data sets used in this research are summarised in Table 6.1. Raster data, which are not currently supported by PostGIS, were transformed into vector data⁵. Vector data were loaded into

¹<http://developer.postgresql.org/pgdocs/postgres/plpgsql.html>

²<http://www.joeconway.com/plr/>

³<http://qgis.org/>

⁴<http://www.google.com/earth>

⁵The transformation was performed by the gdal_polygonize utility (http://www.gdal.org/gdal_polygonize.html), which creates a polygon for each connected region of raster cells sharing a common value.

Table 6.1: Spatial data sets

<i>Data set</i>	<i>Description</i>	<i>Format/resolution</i>	<i>Source</i>
London Atmospheric Emissions Inventory (LAEI) 2008 Modelling Maps	Modelled annual average PM10 and NO ₂ concentrations	Raster: 20 × 20m cells	Greater London Authority, via email request
Environmental Noise (England) Regulations 2006; London Agglomeration – Road Traffic Noise Map	Modelled daytime noise exposure from road traffic	Raster: 10 × 10m cells	Department for Environment, Food and Rural Affairs, via request under Environmental Information Regulations 2004
Heathrow airport noise exposure contours 2009 (standardised)	Modelled average summer day noise exposure, assuming standard East/West split for take-off/ landing	Vector: contours	Environmental Research and Consultancy Department, Civil Aviation Authority, via Department for Transport (DfT) website
Land Cover Map 2000	Highest-likelihood remote-sensed broad habitat classification	Raster: 25 × 25m cells	Centre for Ecology & Hydrology, Natural Environment Research Council, via LSE Library
Countryside designations	National Parks, National Nature Reserves, and Areas of Outstanding Natural Beauty/National Scenic Areas	Vector: polygons	Natural England, Scottish Natural Heritage, Scottish Government, Countryside Council for Wales, and Dept. of Environment Northern Ireland websites
OpenStreetMap (current at 22 July 2011)	Crowd-sourced map including parks, heaths, commons, village greens and recreation grounds	Vector: polygons	cloudmade.com (see also openstreetmap.org)
Greater London Authority (GLA) open space data	Open spaces including parks, gardens, green corridors, sports areas, cemeteries and allotments	Vector: polygons	Greenspace Information for Greater London (GiGL)
GLA 'areas of deficiency'	Areas more than 1km actual walking distance from green space of city or borough importance (\approx major parks)	Vector: polygons	Greenspace Information for Greater London (GiGL)
Weather Underground	UK personal weather station data	Vector: points (panel)	wunderground.com
Crime statistics at sub-ward level for the financial year 2008/09	Reported crime counts by LSOA	Geocoded: LSOA	Metropolitan Police Service, via request under Freedom of Information Act 2000
Nationwide House Price Index, mid-1995 – mid-2004	All Nationwide mortgages approved over the period, with price paid and property characteristics	Geocoded: full postcode	Nationwide Building Society, via Spatial Economics Research Centre, LSE
OS Meridian 2	Map including roads, rivers, railways	Vector: points, lines, polygons	Ordnance Survey, via EDINA Digimap
London Underground stations	Station data including travel zone	Vector: points	Transport for London
Experian Mosaic Public Sector 2010	Population and household counts by LSOA	Geocoded: LSOA	Census Dissemination Unit, MIMAS
National Statistics Postcode Directory (December 2009)	Postcode centroids and classifications within higher-level geographies	Vector: points	Office for National Statistics Geography, via UKBORDERS
Code-Point with polygons	Maximum spatial extent of each postcode	Vector: polygons	Ordnance Survey, via EDINA Digimap
Population density	UK population density grid	Raster: 1 × 1km cells	UNEP World Conservation Monitoring Centre

the database using the appropriate tools⁶. Geocoded data were interpreted using the National Statistics Postcode Directory (NSPD), Code-Point with Polygons, or Experian Mosaic Public Sector data sets.

Where necessary, spatial location data were converted to the Ordnance Survey National Grid spatial reference system (OSGB36), which expresses locations in terms of metres east and north of an origin point in the English Channel (Ordnance Survey, 2008)⁷.

6.1.1.1 Air pollution

Air pollution values within Greater London are derived using the modelling maps produced by the Environmental Research Group, Kings College London. These maps are the product of a dispersion model using data on mobile, point and area pollutant sources from the London Atmospheric Emissions Inventory (LAEI) 2008, weather conditions and street canyons⁸ (Kelly et al., 2011). They provide annual average estimates in 20m cells of the concentrations of nitrogen dioxide (NO_2) and particulates less than 10 microns in diameter (PM10), and of the number of days of the year on which PM10 concentrations exceeded the EU limit of $50\mu\text{g}/\text{m}^3$.

6.1.1.2 Road traffic noise

We use Defra's Road Traffic Noise Map data (Defra, nd). These data have been modelled based on data on traffic flow, road type and vehicle type, and accounting for features affecting the spread of noise, including buildings, ground elevation, and acoustic absorbency/reflectivity. The data provide annual average noise level indicators for 2006 at a receptor height of 4m above ground. They are not informed by actual noise measures, and will not necessarily provide an accurate description of noise levels at specific locations.

The noise level indicators are based on estimated A-weighted decibel values — abbreviated dB(A) — which are units of sound pressure level adjusted to allow for the varying sensitivity of the human ear at different frequencies. Noise levels, and the acceptability of any given noise level, both vary through time, so the indicators are calculated as follows:

L_{day} is the A-weighted average sound level between 7am and 7pm.

L_{evening} is the A-weighted average sound level between 7pm and 11pm.

L_{night} is the A-weighted average sound level between 11pm and 7am.

L_{den} is a logarithmic composite of the L_{day} , L_{evening} , and L_{night} levels but with 5 dB(A) being added to the L_{evening} value and 10 dB(A) being added to the L_{night} value.

In this research we use the L_{den} estimates, which are reported for 10m cells in 5 dB(A) bands between 55 and 75 dB(A). The data cover the London Agglomeration, which is defined according to population densities and does not correspond to any administrative region. They are illustrated in Figure 6.1.

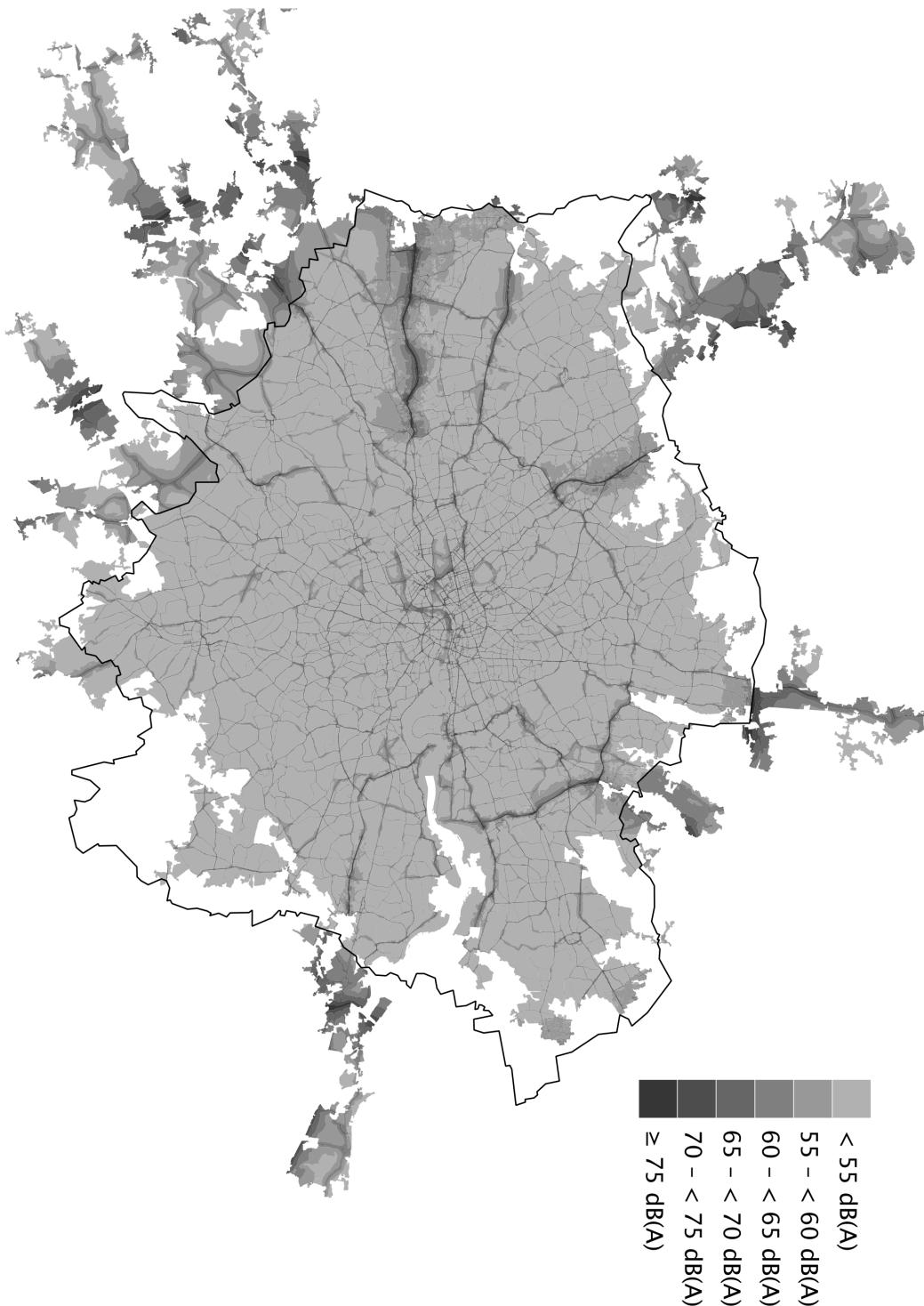
6.1.1.3 Aircraft noise

We use data on aircraft noise around Heathrow Airport estimated on behalf of the Department for Transport. The data are generated by a computer model, validated with noise measurements, which calculates the emissions and propagation of noise from air traffic. They express aircraft noise as L_{eq} values, which correspond to the hypothetical steady sound that would contain the same sound energy as the actual, variable sound, measured over a defined period using the A-weighted scale (Jones & Cadoux, 2009).

⁶ESRI Shapefile data were imported with the PostGIS shp2pgsql utility. AutoCAD DXF files were imported using DXF2PostGIS (<http://www.glasic.it/dxf2postgis.html>). Osmosis (<http://wiki.openstreetmap.org/wiki/Osmosis>) was used to load OpenStreetMap data.

⁷For example, LCM data for Northern Ireland were originally defined using eastings and northings in the Irish Grid system, and our ESM point locations were defined by latitude and longitude values in the global coordinate system (WGS84) used by GPS receivers.

⁸By analogy with natural canyons — deep ravines between cliffs — urban or street canyons exist where streets pass between tall buildings on both sides, affecting airflow and the accumulation/dispersal of pollutants.



Data © Crown copyright 2006

Figure 6.1: Road traffic noise data (2006 L_{den} indicator) against outline of Greater London.



Data © Crown copyright 2008

Figure 6.2: Heathrow Airport 2008 standard modal split (76% West, 24% East) average summer day (7am – 11pm BST) L_{eq} noise contours against outline of Greater London

We used the data calculated from 2008 flight volumes using the long-term average split in the direction of runway use. They are provided as contours of constant L_{eq} value, in 3 dB(A) steps from 57 dB(A) — the Government's guideline value for significant community annoyance. They are depicted in Figure 6.2.

Data from London City Airport are not available in an appropriate format for spatial processing. However, visual inspection of noise maps shows that noise levels above 57 dB(A) barely extend beyond the airport's perimeter.

6.1.1.4 Land cover

The Land Cover Map 2000 (LCM) provides a census of habitats across the UK by classifying satellite image data according to known spatial, spectral and contextual characteristics of land cover (Fuller et al., 2002b). We used the 25m raster LCM data set, which identifies the highest-likelihood 'level 2 subclass' habitat for each 25m cell. These data are illustrated (for the Greater London area only) in Figure 6.3.

We grouped the 26 level 2 subclasses into the same broad habitat categories as used in the UK National Ecosystem Assessment (UK NEA, 2011). There was one exception: the NEA 'urban' habitat (which accounts for almost 75% of our ESM responses) was kept split into its two constituent LCM subclasses, 'continuous urban' and 'suburban/rural developed'. The nine habitat categories used are given in Table 6.2.

Field survey data from the Countryside Survey 2000 have been used to evaluate the quality of LCM data in Great Britain; the comparison suggests that the LCM may classify its 16 'target' classes, which are aggregates of the subclasses, with around 85% success (Fuller et al., 2002a). In most cases our habitat categories aggregate whole target classes, and thus should also be classified with at least 85% success⁹.

⁹The exceptions are our 'continuous urban' and 'suburban/rural developed' categories (which together comprise the single target class 'urban and suburban'), and our 'mountains, moors and heathlands', 'semi-natural grasslands', and 'enclosed farmland', which split some subclasses of the target classes 'neutral / calcareous semi-natural / rough grasslands' and 'acid grass and bracken' between them.

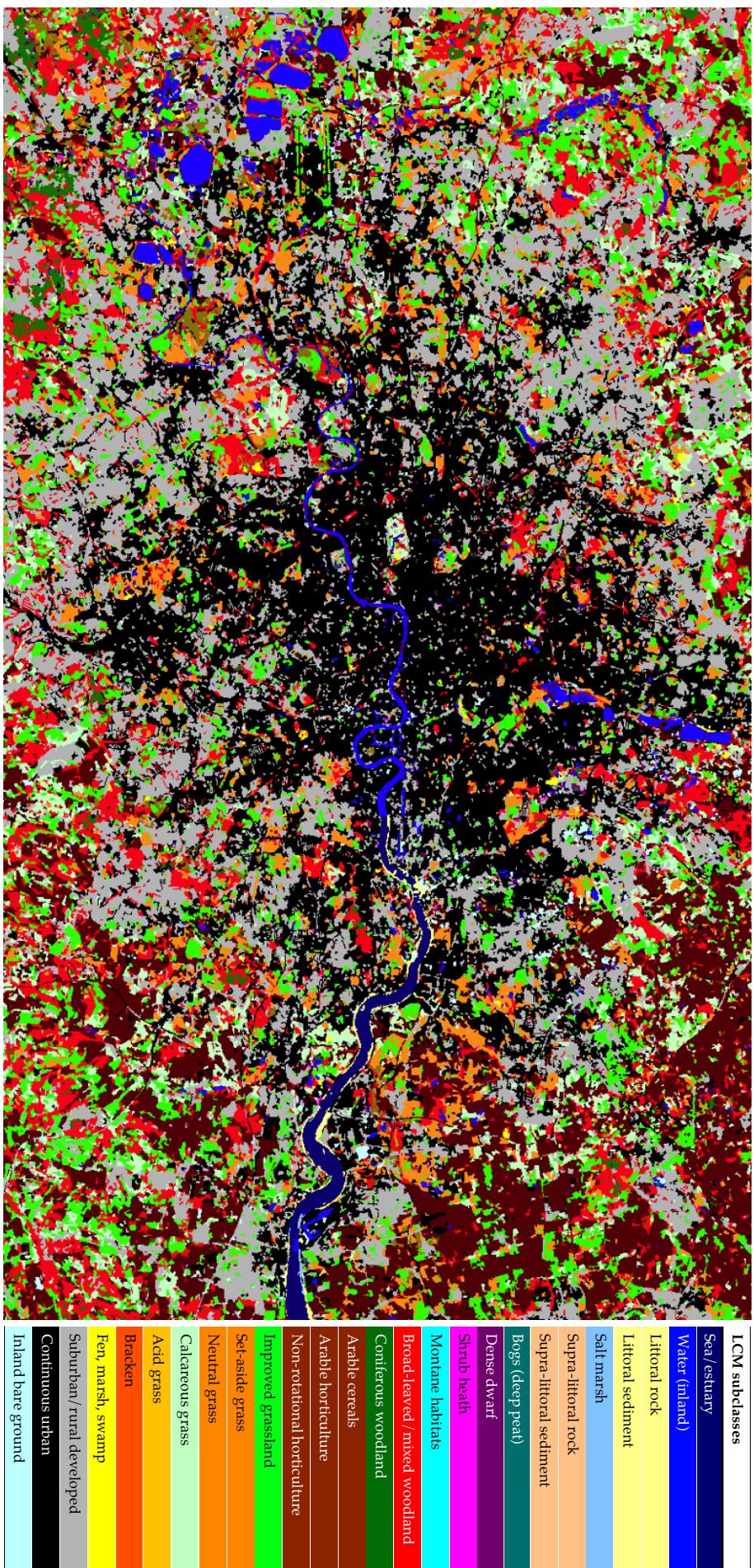


Figure 6.3: Land Cover Map 2000 data around Greater London

Table 6.2: Broad habitat classification of Land Cover Map 2000 subclasses

<i>Habitat categories</i>	<i>LCM level 2 subclasses</i>	
Marine and coastal margins	22.1	Sea/estuary
	20.1	Littoral rock
	21.1	Littoral sediment
	21.2	Salt marsh
	18.1	Supra-littoral rock
	19.1	Supra-littoral sediment
Freshwater, wetlands and flood plains	13.1	Water (inland)
	11.1	Fen, marsh, swamp
Mountains, moors and heathland	12.1	Bog
	10.1	Dwarf shrub heath
	10.2	Open shrub heath
	15.1	Montane habitats
	9.1	Bracken
Semi-natural grasslands	6.1	Rough grass
	7.1	Calcareous grass
	8.1	Acid grass
Enclosed farmland	4.1	Cereals
	4.2	Horticulture/non-cereal or unknown
	4.3	Not annual crop
	5.1	Improved grassland
	5.2	Set-aside grass
Woodland	2.1	Coniferous woodland
	1.1	Broad-leaved/mixed woodland
Suburban/rural developed	17.1	Suburban/rural developed
Continuous urban	17.2	Continuous urban
Inland bare ground	16.1	Inland bare ground

Table 6.3: Weather condition keywords

Condition	Keywords
Rain	Thunderstorm, Squalls, Rain, Showers, Drizzle
Fog	Fog, Mist
Cloud	Cloudy, Overcast
Clear	Clear, Scattered clouds
Snow	Snow

6.1.1.5 Countryside designations

We used data on three types of statutory landscape designation, described as follows by Natural England¹⁰ (but applied across the UK):

National Parks are “extensive tracts of country that are protected by law for future generations because of their natural beauty and for the opportunities they offer for open air recreation”. There are 15 National Parks in the UK, and they cover approximately 9% of the land area. None are in Northern Ireland.

Areas of Outstanding Natural Beauty (AONBs) are “areas of high scenic quality that have statutory protection in order to conserve and enhance the natural beauty of their landscapes [...] different from National Parks because of their more limited opportunities for extensive outdoor recreation”. We treat Scotland’s National Scenic Areas (NSAs, described by Scottish Natural Heritage as areas “of outstanding scenic value in a national context”) as equivalent to AONBs, and in all subsequent uses intend both by that term. There are 86 AONBs in the UK, covering approximately 15% of the land area.

National Nature Reserves (NNRs) were “initially established to protect sensitive features and to provide ‘outdoor laboratories’ for research [...] and] now offer great opportunities to the public as well as schools and specialist audiences to experience England’s natural heritage”. NNRs cover approximately 1% of the UK’s land area.

The designation areas are shown in Figure 6.4. Some areas of land are assigned multiple designations.

6.1.1.6 Daylight

Sunrise and sunset times, which define the period of daylight, vary by date and location. These times were calculated for every ESM response using the R *StreamMetabolism* package (Sefick, 2009) accessed via PL/R. The associated code is shown in section C.1 on page 397 of Appendix C.

6.1.1.7 Weather

Weather reports from 280 personal weather stations operated by private individuals across the UK were downloaded hourly from the Weather Underground website¹¹ throughout the study period, and processed using a custom Ruby script¹². The weather station locations are shown in Figure 6.5. Temperature, windspeed, humidity and atmospheric pressure values were extracted directly. General conditions were identified from text descriptions according to the keywords listed in Table 6.3. Sunny conditions were identified as the interaction of clear skies and daylight.

These data were selected for their availability and for their high spatial and temporal resolution. The accuracy of the data, which are collected using different equipment in different locations, is not specified (use of the Met Office’s MIDAS Land Surface Stations data might be preferable in future research).

¹⁰<http://www.naturalengland.org.uk/ourwork/conservation/designatedareas/>

¹¹<http://www.wunderground.com/>

¹²This script parsed and extracted the data of interest from the thousands of downloaded HTML pages using the Hpricot parsing library (<http://rubydoc.info/gems/hpricot/0.8.4/frames>).



England data: Contains, or is based on, information supplied by Natural England. Contains, or is derived from, information supplied by Ordnance Survey. © Crown copyright and database right 2011. All rights reserved. Ordnance Survey Licence number 100022021. Wales data: © Crown copyright. All rights reserved. Country side Council for Wales, 100018813 2011. Scotland data: © Crown copyright and database right. 2011. All rights reserved. Northern Ireland data: This material is based upon Crown Copyright and is reproduced with the permission of Land & Property Services under delegated authority from the Controller of Her Majesty's Stationery Office, Crown copyright and database rights, EMOU206.2. Northern Ireland Environment Agency Copyright 2011.

Figure 6.4: Statutory landscape designations: (a) National Parks, (b) Areas of Outstanding Natural Beauty and National Scenic Areas and (c) National Nature Reserves.

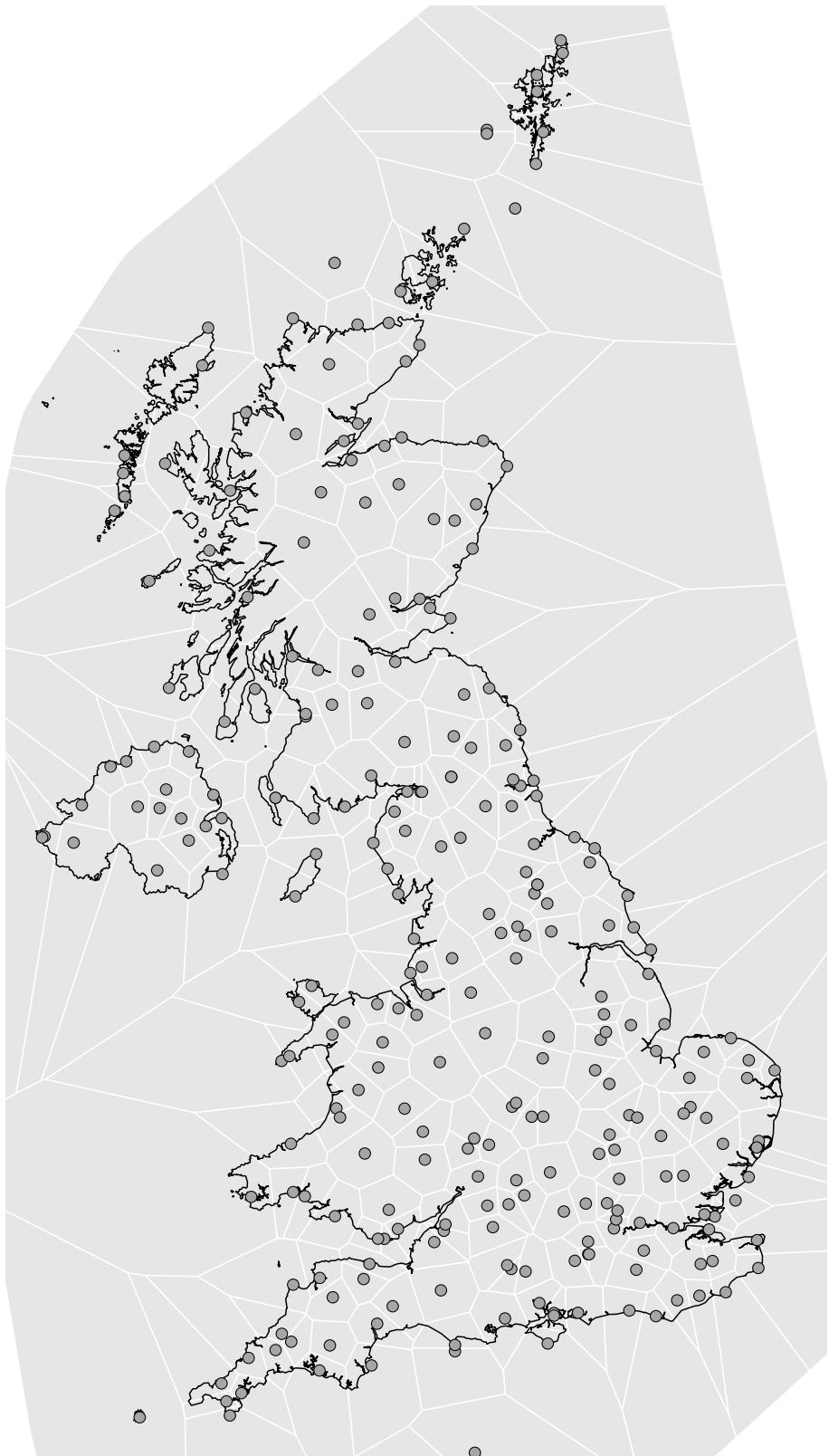


Figure 6.5: Weather station locations, and the regions for which they are the nearest stations

Table 6.4: OpenStreetMap key/value tags used to identify green spaces and parks

<i>Green spaces</i>	<i>Public parks</i>
leisure/park	leisure/park
leisure/common	leisure/common
landuse/village_green	landuse/village_green
landuse/recreation_ground	landuse/recreation_ground
landuse/forest	
landuse/meadow	
landuse/allotments	
natural/wood	
natural/heath	
natural/fell	
natural/marsh	
natural/wetland	

6.1.1.8 Crime

We use data from the Metropolitan Police for the financial year 2008 – 09 regarding total notifiable offences, residential burglary and violence against the person. These data are geocoded to Lower Super Output Area (LSOA) level¹³. For violence against the person and total notifiable offences we use Office for National Statistics (ONS) mid-2008 LSOA population estimates to derive crime rates expressed per person. For residential burglary we use Experian Mosaic Public Sector 2010 household counts to calculate the rate per household.

6.1.1.9 Urban green space

We wanted to join the London survey data with information on high-quality, publicly-accessible green spaces. However, the UK suffers a ‘green information gap’ regarding urban green spaces: “nobody knows how many there are, where they are, who owns them or what they are like” ([CABE Space, 2009](#)). We therefore try three different approaches.

Land Cover Map 2000 We use LCM data (see [subsubsection 6.1.1.4](#)) to identify green spaces. We consider as green spaces these four habitat types, as specified in [Table 6.2](#): mountains, moors and heathland; semi-natural grasslands; enclosed farmland; and woodland.

OpenStreetMap OpenStreetMap (OSM) “aims to create a free digital map of the world and is implemented through the engagement of participants in a mode similar to software development in Open Source projects. The information is collected by many participants, collated on a central database, and distributed in multiple digital formats” ([Haklay, 2010, p. 682](#)).

We use OSM data as another route to identifying green spaces in London. The advantage of OSM data over traditional map data sources for this purpose is that map features are tagged with a richer variety of information regarding land cover and use. The disadvantages are that the data set may not be complete and tags may not be applied consistently.

We identify green spaces — and a subset of these, public parks — as areas tagged with the key/value pairs listed in [Table 6.4](#).

GiGL/GLA data Greater London Authority (GLA) data on green spaces is collated from the London borough authorities by Greenspace Information for Greater London (GiGL). We use two GLA data sets provided by GiGL. The first maps public open spaces of various kinds, which are predominantly green spaces. The second maps Greater London’s “Areas of Deficiency” (AoD), which are defined as locations that are more than 1km actual walking distance from a green space site of borough- or city-wide importance (these being, in general, large public parks).

¹³LSOAs were created by aggregating 2001 Census Output Areas (typically 4 – 6). They are designed to have a minimum population of 1,000 and a mean population of 1,500.

6.1.1.10 House prices

Data on house prices are required for the purposes of SWB valuation as noted in [subsubsection 2.2.3.1](#).

We use data provided by the Nationwide building society, covering approximately 800,000 UK transactions between mid-1995 and mid-2004. The transactions are geocoded at full postcode level. They include the sale price and detailed house characteristics: property type, floor area, number of bathrooms, number of bedrooms, central heating (by extent and type of fuel), parking facilities (space, single garage, double garage, none), tenure, age and whether new-build, and the year and month of sale.

For SWB valuation purposes we need information on the contribution of spatial factors to house prices after controlling for housing characteristics and housing market fluctuations. We extract this information at two scales.

First, we associate the transaction postcodes with their LSOAs (or equivalently, for transactions in Scotland, Scottish Data Zones). We estimate a fixed-effects regression model with the LSOAs as the groups, and use the fixed effects as per-LSOA standardised house price indicators. Second, we estimate a simple OLS regression model, and use the regression residuals as per-transaction standardised prices. The regression specifications and results for both models are given in [Appendix C](#).

This approach assumes that spatial influences on house prices are reasonably stable over the period from 1995 to the web survey fielding dates.

6.1.1.11 London Transport

We estimate the extent of the London Transport central travel zone (Zone 1) as a convex hull¹⁴ for all Zone 1 London Underground stations.

6.1.2 Spatial joins

6.1.2.1 Geocode matching

Survey response postcodes were matched with crime rates and per-LSOA house prices via a lookup table. Each response postcode was associated with an LSOA code using the NSPD, and the LSOA code was then associated with the crime rate and house price data.

6.1.2.2 Within/contains

In many cases response data were associated with spatial data via simple 'within' or 'contains/covers' join queries. For example: a dummy variable indicating National Park designation was set if an ESM response location fell within any of the polygons defining the extents of that designation; and a categorical variable indicating the LCM subclass was set to the subclass code associated with the polygon containing the response location. In the case of contour data, the value assigned to a location corresponds to the highest value associated with any of the contour polygons covering it.

6.1.2.3 Distance to nearest

In other cases, the straight-line distance to the nearest feature of a particular type was calculated: for example, the distance from a respondent's home to the nearest point on a river or motorway or perimeter of a National Park. Where the measurement origin point was inside a two-dimensional feature such as a National Park, the distance was taken to be zero.

¹⁴A convex hull is most easily understood as follows. Imagine a set of points as nails protruding from a board. The shape that would be made by an elastic band placed around all the nails is the convex hull for those points.

6.1.2.4 House prices: median of nearest N

In addition to the house price information calculated at LSOA level, a more localised house price indicator was calculated for each survey response location as the median of the standardised sale prices (regression residuals) of the N nearest transactions.

The choice of N represents a balance between spatial resolution (better at low N) and robustness to unrepresentative values (better at high N), and is somewhat arbitrary. For this calculation we set $N = 9$.

6.1.2.5 Weather conditions: closest in space and time

We assume that current weather conditions at a location are correlated with weather conditions a short time earlier or later at nearby locations. ESM response data was therefore associated with weather data by selecting the nearest weather station to the response location, and then selecting the data reported by that station at the moment closest to (either before or after) the response time.

To rapidly locate the nearest station for millions of response locations, we pre-calculated for each station the region for which it was the nearest station¹⁵ using the R *deldir* package (Turner, 2010) accessed via PL/R. These regions are shown in Figure 6.5. We were then able to locate the nearest station to a response using a simple ‘contains’ query as above.

Limitations The weather variables associated with the ESM response data in this way can only be regarded as somewhat noisy proxies for the weather conditions experienced by participants. We cannot account for the possible existence of weather fronts between the observation and response locations. We also do not account for a number of topographical effects, including: adiabatic cooling, which causes lower air temperatures to prevail at higher elevations¹⁶; moderation of local air temperatures, and production of sea and land breezes, by oceans and other large water bodies; and variations in wind speed owing to the sheltered or exposed aspects of different locations. We also do not account for the impacts of humidity and wind chill on perspiration rates and, consequently, apparent temperature. Although we do not expect that these sources of noise will have a substantial effect on our results¹⁷, future researchers might wish to consider a more sophisticated approach.

6.1.2.6 Land cover: proportion of local area

Measures of the local availability of different land cover types were calculated for each survey response location as kernel-weighted proportions.

A kernel-weighted proportion measures the area of land around a point that meets specific criteria (for example, is public green space) as a fraction of the area of all the land around that point. These numerator and denominator areas are both weighted, using a kernel function, according to proximity to the central point (they can therefore usefully be imagined as three-dimensional volumes, for which the height dimension at any point represents the weighting applied at that point). The kernel function is usually chosen so that higher weightings are applied to nearer locations.

Common kernels include the uniform — in which case the quantities become simple proportions within a given radius — triangular, Gaussian (normal), and Epanechnikov. For a given kernel, one must also select the appropriate bandwidth distance, which determines the rate at which the applied weightings decline with distance. For example, for the Gaussian kernel, one can define the desired standard deviation¹⁸.

¹⁵Such regions are known as Voronoi, Thiessen or Dirichlet polygons or cells (De Smith et al., 2007, p. 124).

¹⁶The adiabatic lapse rate — the rate at which rising air cools due to falling atmospheric pressure — averages 0.6 – 0.7°C per 100 metres globally, but varies depending on humidity and other factors (Encyclopædia Britannica, 2012).

¹⁷For example, in the case of adiabatic cooling, 99.9% of responses are between 0 and 320m above sea level, with expected temperature variation of the order of only 2°C across that range. Furthermore, since response locations and weather observation locations are near to each other, elevation, and hence the extent of adiabatic cooling, are expected to be correlated between them.

¹⁸For the Gaussian kernel one may also choose a truncation distance (for example, at two or three standard deviations) beyond which weightings will be approximated to zero, otherwise all data must be used in calculating all proportions, which is computationally expensive.

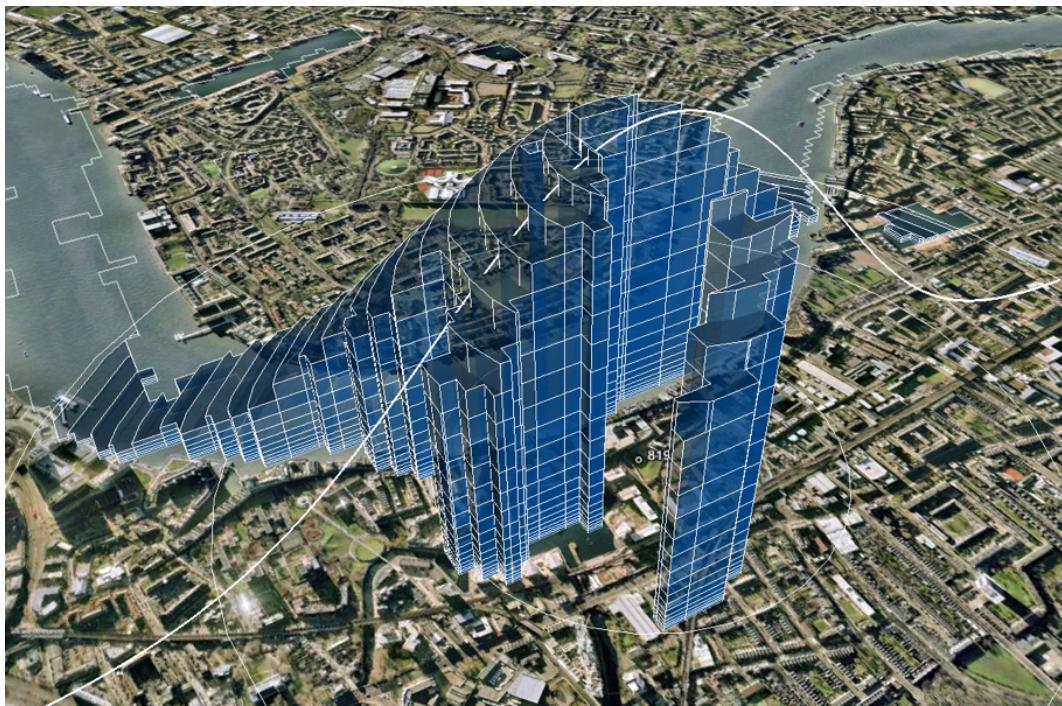


Figure 6.6: Illustrated example of the approximation of the Gaussian kernel-weighted proportion of water near a point location. Kernel weights are represented as the height dimension.

Table 6.5: Proportion measures calculated for London and UK data

Location and data	Kernel, bandwidth parameter	
	Uniform, radius	Gaussian, std. dev. [†]
UK, LCM types	1km, 3km, 10km	200m, 1km
London, green and blue space indicators	200m, 1km, 3km	200m, 1km

[†] Gaussian kernel-weighted proportions are truncated at 3 standard deviations.

We calculated approximate kernel-weighted proportions by summing series of simple proportions over appropriate radii from the central point. This approach is visualised in Figure 6.6. The PostGIS functions implementing these calculations are shown in section C.3 on page 397 of Appendix C.

What is local? We calculate proportion measures for LCM land cover types (UK survey) and areas of green and 'blue' space under various definitions (London survey). In choosing appropriate bandwidth values, we are guided by several considerations.

First, what values have been used in the literature? As noted in section 1.2, proportion measures have not previously been used in SWB studies. However, Maas et al. (2006 and 2009) calculate land cover proportions within 1km and 3km radii in epidemiological studies, and in their hedonic pricing work Gibbons et al. (2011) take the proportion in a 1km grid square.

Second, what is the lowest reasonable bandwidth given the precision of our locations and the resolution of our EQ data? Location accuracy constrains this quantity more than the EQ data, particularly in the case of the UK survey, where we use a postcode centroid that may be up to several hundred metres from the target location.

Third, what is the highest bandwidth that is not computationally prohibitive? This is an issue primarily for kernel-weighted proportion calculations, which are more computationally intensive.

Finally, what is our intuition: over what distances from the home does it seem reasonable that one's SWB might be affected by environmental characteristics?

These considerations lead us to calculate the proportion measures shown in Table 6.5.

6.2 Happiness models

All econometric analyses were performed using either Stata or R ([StataCorp, 2009b](#); [R Development Core Team, 2011](#)).

6.2.1 Cross-sectional survey data

In our survey data we model the reported happiness r of individual i as:

$$r_i = \alpha + \beta_{\ln w} \ln w_i + \beta'_x x_i + \beta_{\ln v} \ln v_i + \beta'_y y + \varepsilon_i \quad (6.1)$$

where α is a constant, w is the wage, x is a vector of other individual characteristics, v is the rent or land value, y is a vector of other local amenities and environmental conditions, and ε is an error term.¹⁹ This specification, and its use for monetary valuation, are considered in more detail in subsection 2.2.3. Following [Ferreira & Moro \(2010, p. 257\)](#) we use household income as a proxy for wages.

As noted in subsection 2.2.2, ordered models (logit and probit) have dominated the economic literature on happiness, but OLS models have generally given comparable results and may be preferable because of the straightforward interpretation of the coefficients. We report OLS model estimates from our survey data, having verified that these are indeed comparable to the results from ordered models²⁰.

In case there is heteroskedasticity in the residuals we report Huber/White/sandwich estimators of the standard errors. In the London data set some spatial explanatory variables are joined with our observations at area (LSOA) level; in this case, we use cluster-robust sandwich estimators in case of correlation of the residuals within observations from the same area.

6.2.2 Panel data from ESM assessments

6.2.2.1 Fixed effects model

The ESM study data represent a very large, unbalanced panel, with large N (the number of individuals) and highly variable T (the number of assessments per individual).

We model the reported happiness r of individual i at location l and time t as:

$$r_{ilt} = \alpha_i + \beta'_p p_{ilt} + \beta'_q q_{ilt} + \varepsilon_{ilt} \quad (6.2)$$

where α is an individual-specific constant or fixed effect, p is a vector of contextual factors such as companionship and activity, q is a vector of local amenities and environmental conditions (which may vary through time), and ε is an error term.

We estimate the model in (6.2) using the fixed effects or within estimator, of which [Wooldridge \(2009, pp. 481 – 489\)](#) and [Greene \(2003, pp. 287 – 293\)](#) provide standard treatments, and which in its basic form is exactly equivalent to OLS regression in which a dummy variable is included for each individual (the 'least-squares dummy variable regression')²¹.

We cannot include in our model any time-invariant individual-level influences on reported happiness, such as personality characteristics or gender, since all such influences are swept up by the individual-level fixed effects. However, the estimator allows for arbitrary correlation between any individual effects (including unobserved effects) and the observed explanatory variables. This is an important property, since such correlations seem likely to exist in our data. For example, personality characteristics may very plausibly be associated with the companionship, activity and environment that a person can and does choose at any moment in time.

¹⁹We do not use an additional subscript for location in equation (6.1), as is sometimes seen in the literature, since most of our spatial variables are specific to each individual respondent (to within 25m or less).

²⁰See, for example, [Greene \(2003, chapters 2 and 21\)](#) for treatments of OLS and ordered models.

²¹In the EMA literature this approach may be described as "pooled within-person regression" ([Schwartz & Stone, 1998, pp. 9 – 10](#)).

Basic, pooled OLS fixed effects estimation requires that the errors ε are homoskedastic and not serially correlated (Wooldridge, 2009, p. 483). The serial correlation restriction is likely to be problematic for our data, since it seems highly plausible that unobserved influences on a person's happiness may persist from one response to the next. Therefore standard errors are calculated using the cluster-robust sandwich estimator (StataCorp, 2009a, p. 463), which is robust in the face of heteroskedasticity and serial correlation of the errors (Stock & Watson, 2008, p. 164).

6.2.2.2 Estimators not used

The random effects estimator is also a common model in panel data analysis, and is more efficient, since it does not discard data on the variation between individuals. It also enables the analysis of time-invariant individual-level effects. However, we do not use the random effects estimator because (a) individual-level variables are not of primary interest in this study; (b) our data set is large enough that efficiency considerations are not key; and (c) the assumption that unobserved individual effects are uncorrelated with any of the explanatory variables, which is required for the random effects estimator to be unbiased, does not seem reasonable.

Multi-level mixed-effects models estimated using maximum likelihood techniques have also been favoured for EMA data analysis by some researchers (Schwartz & Stone, 1998, 2007). However, these models are also random effects models. We therefore do not use them for the same reasons outlined above, and also because their use with such a large data set would be highly computationally expensive (especially since much tuning and many runs may be necessary to achieve convergence).

6.3 Summary

In this chapter we have outlined the wide range of high-resolution spatial data sets with which we have joined our survey and ESM data, and the methods by which we have done so. As noted in [chapter 1](#), in many cases the use of these spatial data sets and methods represents an original contribution to the literature in happiness economics and EQ. We have also set out the econometric models to be used in the analysis of the resulting combined data.

This concludes our discussion of methods. In the following two chapters we present and discuss the findings from our survey and ESM research strands respectively.

Chapter 7

Retrospective happiness and the usual environment

In this chapter we characterise and analyse responses and associated spatial data from the cross-sectional surveys of UK and London residents described in [chapter 4](#), in order to investigate relationships between individuals' retrospective SWB evaluations and levels of EQ around their homes and workplaces. As outlined in earlier chapters, this work incorporates substantial methodological improvements over previous research in this area. In spite of this, however, our findings are somewhat mixed.

Section [7.1](#) describes our data, including the demographic characteristics of respondents, their SWB responses, and the spatial and non-spatial variables we will use to predict these. Section [7.2](#) reports on the regression analyses we run to investigate the effects of a variety of EQ characteristics, around individuals' homes and workplaces, on a number of different indicators of SWB. In [section 7.3](#) we discuss our findings.

7.1 Descriptive results

7.1.1 Demographics and sample representativeness

As discussed in [subsubsection 4.1.2.3](#), both web surveys used quota sampling. Basic demographic characteristics in the samples should therefore be close to representative of the respective populations. Tables [D.1](#), [D.2](#), [D.3](#) and [D.4](#) in Appendix [D](#) provide full demographic information for the UK and London surveys, alongside comparator data where available.

The samples are indeed broadly representative on key characteristics. However, in each case the oldest age group (65+) is slightly under-represented and the 45 – 64 group somewhat over-represented. Similarly, those with degree-level qualifications are somewhat over-represented and those with no qualifications under-represented. These discrepancies may well reflect the differential penetration of Internet access demonstrated in [Table 4.1](#). Those in paid employment are also somewhat under-represented in both surveys.

7.1.1.1 Income

Incomes in our survey data appear similar to, or very slightly below, those reported in large-scale surveys using probability sampling.

For the UK as a whole in 2004/05, median gross annual household income was £24,700, while the mean was £31,884 ([House of Commons, 2006](#)). These values are closely matched in our UK survey data, in which the median household income bracket is £23,000 – £25,999, and the mean of the bracket midpoints is £29,331.

In London in 2006, median gross weekly pay for full-time employees was £541 ([Office for National Statistics, 2007a](#)). The median individual income bracket for employees in the London survey

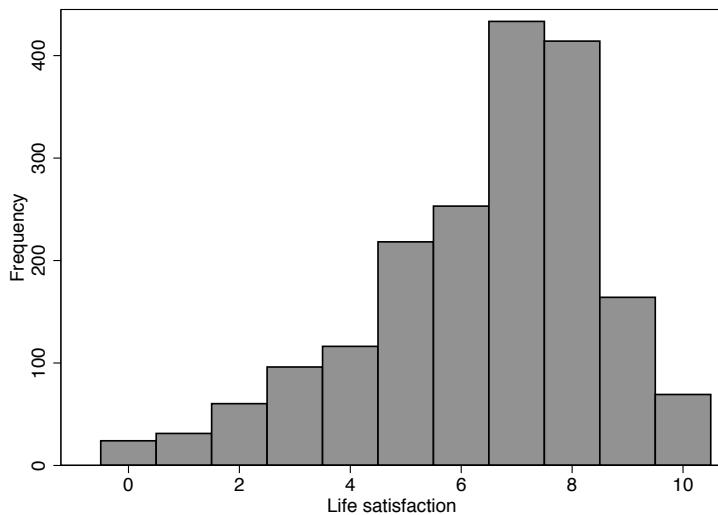


Figure 7.1: Distribution of life satisfaction ratings, UK web survey

data is consistent with this, being equivalent to £498 – £556 per week¹. Average gross household income for London during 2003 – 2006 was £766 per week ([Office for National Statistics, 2007a](#)). Our mean of annual gross household income bracket midpoints is slightly lower, at £36,002, equivalent to £690 per week.

Household income distributions in the two surveys are shown in Figures D.1 and D.2 in Appendix D.

Equivalence scales A household's needs grow with each additional member but, owing to economies of scale in consumption, this growth is not proportional.

"With the help of equivalence scales each household type in the population is assigned a value in proportion to its needs. The factors commonly taken into account to assign these values are the size of the household and the age of its members (whether they are adults or children). A wide range of equivalence scales exist [... but] there is no accepted method for determining equivalence scales, and no equivalence scale is recommended by the OECD for general use" ([OECD, nd](#)).

In this study, we employ an equivalence scale that divides household income by a factor of $\sqrt{a + 0.7c}$, where a is the number of adults and c the number of children in the household, following [Joung et al. \(1997\)](#).²

7.1.2 Subjective wellbeing

Basic life satisfaction responses in both samples follow the familiar right-shifted distribution, as illustrated in Figures 7.1 and 7.2. For the UK, on a 0 – 10 scale, the median and mode are both 7. For London, the median is 7 and the mode is 8.

Descriptive statistics for all subjective wellbeing indicators used in the analyses to follow are presented in [Table 7.1](#). The calculations underlying the multi-item scales are explained in section D.2 in Appendix D.

¹The comparison is not perfectly like-for-like, since our data includes all sources of income (not only earnings) for both full- and part-time employees.

²We also test the sensitivity of our results to the use of the 'OECD-modified' scale, as adopted by EUROSTAT in the late 1990s. This divides by a factor of $0.5 + 0.5a + 0.3c$ where, again, a is the number of adults and c the number of children. The scales are very highly correlated, and our results are all but unchanged by the substitution.

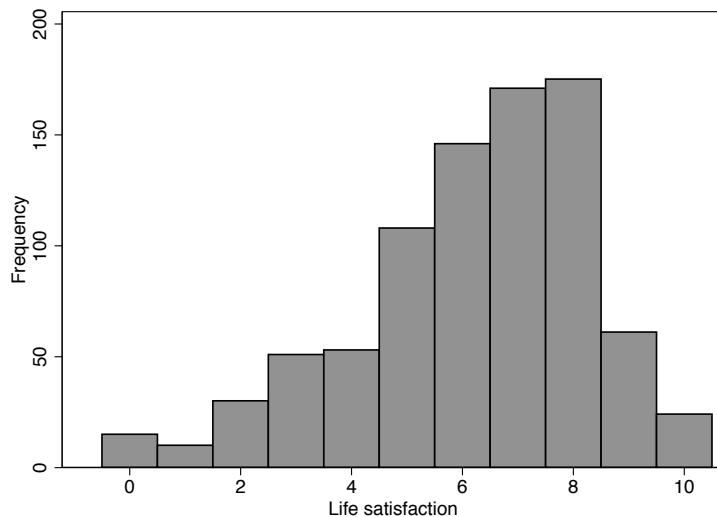


Figure 7.2: Distribution of life satisfaction ratings, London web survey

Table 7.1: Subjective wellbeing variable descriptives, all survey data

	<i>Mean</i>	<i>Std. dev.</i>	<i>Min.</i>	<i>Max.</i>
<i>UK survey</i>				
Life satisfaction	6.40	2.13	0	10
PANAS positive affect	28.95	8.89	10	50
PANAS negative affect	19.16	8.16	10	50
SF-36 emotional wellbeing	63.57	21.29	0	100
<i>London survey</i>				
Life satisfaction	6.20	2.13	0	10
ESS satisfying life	0	0.87	-2.44	1.82
ESS personal wellbeing	0	0.66	-2.07	1.68
ESS personal and social wellbeing	0	0.57	-2.02	1.62

Table 7.2: Spatial variable descriptives, UK web survey data

	Mean	Std. dev.	Min.	Max.
<i>% LCM NEA category within 3km (omitted category: continuous urban)</i>				
Marine and coastal margins	1.14	4.65	0.00	54.50
Freshwater, wetlands and floodplains	0.76	2.11	0.00	43.11
Mountains, moors and heathlands	0.73	2.58	0.00	41.51
Semi-natural grasslands	9.28	7.83	0.00	78.67
Enclosed farmland	28.29	22.56	0.00	94.85
Woodland	7.48	7.23	0.00	60.21
Suburban/rural developed	30.49	16.90	0.00	87.38
Inland bare ground	1.14	2.02	0.00	26.74
<i>Distance (m)</i>				
National Park	44112	30459	0	337661
AONB	22045	16202	0	97019
NNR	14101	8564	208	69053
Coast	19596	22412	24	111751
River	1844	7030	1	112692
Motorway	18688	33338	90	441751
Railway line	3290	11436	12	222153
Railway station	4125	11470	69	222153
Pop. density (LSOA, people/ha)	42.64	39.84	0.02	353.43
Pop. density (km ² , people/ha)	32.69	25.04	0.00	163.93
House price (std. LSOA mean)	-0.08	0.43	-1.47	1.55
House price (std. local median)	-0.07	0.36	-1.12	1.17

7.1.3 Spatial data

All spatial descriptives shown are calculated in relation to respondents' home locations. Distances are given as natural logs of the original measurements in metres³. Population density and house price indicators are each shown at two scales: population density is given both at LSOA level and within a 1km grid cell, while house prices are given both as standardised LSOA means and as standardised local medians, as discussed in section 6.1.

7.1.3.1 UK

All locations in the UK data are postcode centroids. Respondents' home locations are illustrated in Figure 7.3. There are 1,585 in England, 173 in Scotland, 94 in Wales and 26 in Northern Ireland.

Descriptive statistics for key spatial variables are presented in Table 7.2 (for brevity, we show only 3km unweighted proportions for the LCM types, since these are our favoured measures in later analyses).

Correlations between all pairwise combinations of spatial variables are shown in Table 7.3. As expected, the two population density indicators are highly correlated with each other, as are the two house price indicators (these correlated pairs were not intended to be used in the same

³We add 1 to the distances before taking logs, so that zero distances do not become undefined.

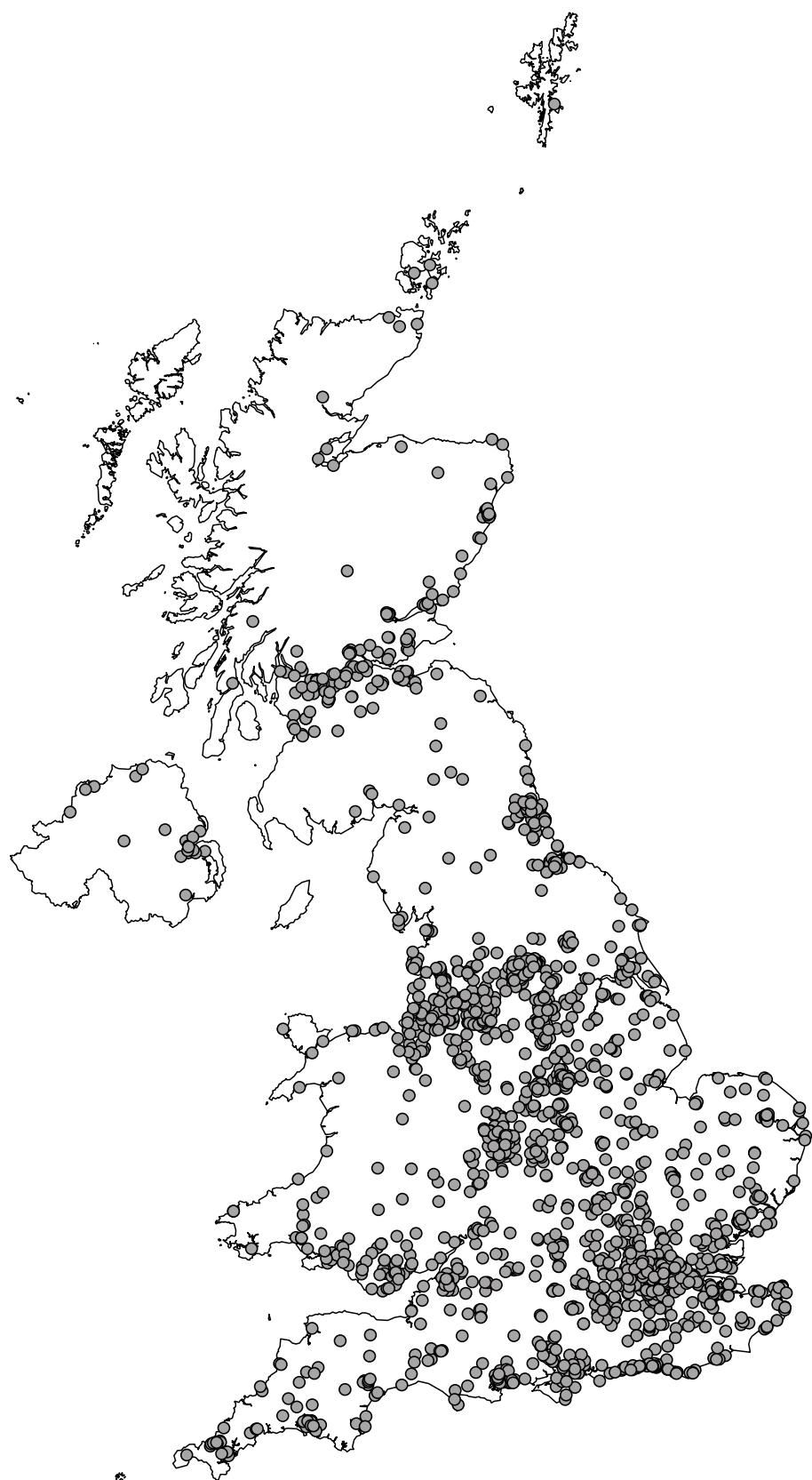


Figure 7.3: Response locations, UK web survey

Table 7.3: Spatial variable correlations, UK web survey data

	Marine and coastal margins [^]	Freshwater, wetlands and floodplains [^]	Mountains, moors and heathlands [^]	Semi-natural grasslands [^]	Enclosed farmland [^]	Woodland [^]	Suburban/rural developed [^]	Inland bare ground [^]	Distance to National Park, ln(m)	Distance to AONB, ln(m)	Distance to NNR, ln(m)	Distance to coast, ln(m)	Distance to river, ln(m)	Distance to motorway, ln(m)	Distance to railway line, ln(m)	Distance to station, ln(m)	Pop. density (LSOA, people/ha)	Pop. density (km2, people/ha)	House price (std. LSOA mean)	House price (std. local median)
Marine and coastal margins [^]	1.00																			
Freshwater, wetlands and floodplains [^]	0.00	1.00																		
Mountains, moors and heathlands [^]	-0.03	0.11	1.00																	
Semi-natural grasslands [^]	-0.09	-0.03	0.21	1.00																
Enclosed farmland [^]	-0.08	-0.15	-0.06	0.09	1.00															
Woodland [^]	-0.14	0.03	0.24	0.20	0.03	1.00														
Suburban/rural developed [^]	-0.02	-0.15	-0.12	-0.12	-0.46	-0.12	1.00													
Inland bare ground [^]	-0.02	-0.01	0.04	0.05	-0.17	-0.10	0.01	1.00												
Distance to National Park, ln(m)	-0.01	-0.09	-0.14	-0.14	0.05	-0.20	-0.03	0.02	1.00											
Distance to AONB, ln(m)	-0.09	-0.02	-0.03	0.02	-0.20	-0.20	0.13	0.03	0.01	1.00										
Distance to NNR, ln(m)	-0.16	-0.04	0.02	0.07	-0.04	0.02	0.02	0.05	0.04	0.11	1.00									
Distance to coast, ln(m)	-0.42	-0.15	-0.02	0.18	0.19	0.21	0.03	0.06	0.08	0.04	0.12	1.00								
Distance to river, ln(m)	0.14	-0.01	-0.05	-0.14	-0.14	-0.09	0.03	-0.02	-0.07	-0.08	-0.09	-0.25	1.00							
Distance to motorway, ln(m)	0.12	0.05	0.08	-0.16	0.25	-0.04	-0.17	-0.18	-0.12	-0.15	-0.08	-0.30	0.02	1.00						
Distance to railway line, ln(m)	-0.03	-0.06	0.11	0.11	0.42	0.16	-0.19	-0.10	-0.02	-0.19	-0.05	0.13	-0.05	0.20	1.00					
Distance to station, ln(m)	-0.03	-0.08	0.13	0.14	0.50	0.15	-0.23	-0.05	-0.01	-0.16	0.00	0.17	-0.09	0.19	0.79	1.00				
Pop. density (LSOA, people/ha)	-0.08	0.09	-0.09	-0.28	-0.54	-0.23	0.11	0.07	0.06	0.16	0.04	-0.18	0.14	-0.08	-0.30	-0.36	1.00			
Pop. density (km2, people/ha)	-0.06	0.09	-0.13	-0.32	-0.63	-0.29	0.17	0.03	0.10	0.18	0.04	-0.17	0.19	-0.14	-0.34	-0.43	0.74	1.00		
House price (std. LSOA mean)	-0.08	0.13	-0.10	-0.22	-0.14	0.09	-0.10	-0.15	0.06	-0.20	-0.16	-0.02	0.09	-0.05	-0.13	-0.23	0.25	0.33	1.00	0.90
House price (std. local median)	-0.12	-0.01	0.15	-0.05	0.16	-0.11	-0.13	0.05	-0.21	-0.14	0.03	-0.05	-0.06	-0.14	0.14	0.20	0.20	1.00		

Off-diagonal correlation coefficients ≥ 0.5 or ≤ -0.5 are in **boldface**.

[^] indicates % LCM NEA category within 3km radius.

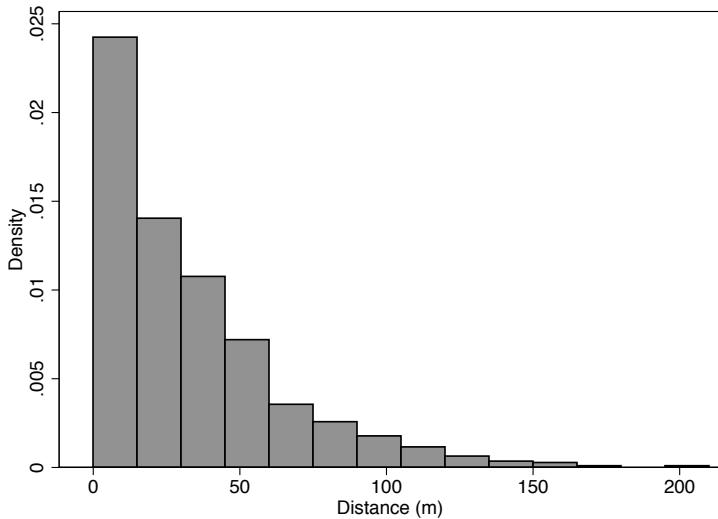


Figure 7.4: Distance from interactive map location to postcode centroid for responses within the postcode polygon, London web survey

regression model). Distances to the nearest railway station and railway line are also highly correlated. To avoid issues of multicollinearity these will also not be entered together in any regression specification (we drop railway line distance). Finally, the proportion of enclosed farmland is substantially correlated with the distance to nearest railway station and (negatively) with the population density indicators.

7.1.3.2 London

Interactive map location We make use of the interactive map location data only where respondents selected the follow-up options “My home is in the yellow box” or “My home is in or near the yellow box—it could be one or two buildings either way” (conversely, we exclude records where respondents checked the options “I couldn’t find my home on the map”, “The map didn’t load/didn’t work”, or “I prefer not to say exactly where I live”).

As a sanity check on the locations indicated by respondents, we compare these map locations with the polygons associated with the respondents’ postcodes. 81% of map locations fall within the associated postcode polygon. 95% are within 25m of the polygon’s perimeter, and all are within 190m.

Responses that are inside the postcode polygon may still be up to 200m from the postcode centroid, as seen in Figure 7.4. This difference between the interactive map and postcode centroid locations translates into non-trivial differences in those environmental quality indicators that vary over short distances. For example, estimated average PM10 concentrations at the home postcode centroid and map location for the same respondent have a correlation coefficient of only 0.75.

We assume that the map locations and associated spatial indicators are closer to the true values, and use these exclusively in the rest of this chapter.

Descriptives Respondents’ home locations are plotted in Figure 7.5, and descriptive statistics for spatial variables are presented in Table 7.4 (again, for brevity, we show only 3km unweighted proportions for green and blue space indicator variables). Notably few respondents are resident in areas of high aircraft or railway noise as identified by the data sets used (2% and 6% respectively).

Spatial variable correlations are shown in Table 7.5. As in the UK data, the two population density indicators are highly correlated with each other, as are the two house price indicators. As one might also expect, substantial correlations are also seen between some green space measures. None of these were intended to be used in the same regression model. Extremely high correlations are seen between the two air pollution indicators (PM10 and NO₂) and two of the crime indicators (Violence Against the Person and Total Notifiable Offences). Again, to avoid issues of multicollinearity, these correlated pairs will not be used together in any regression

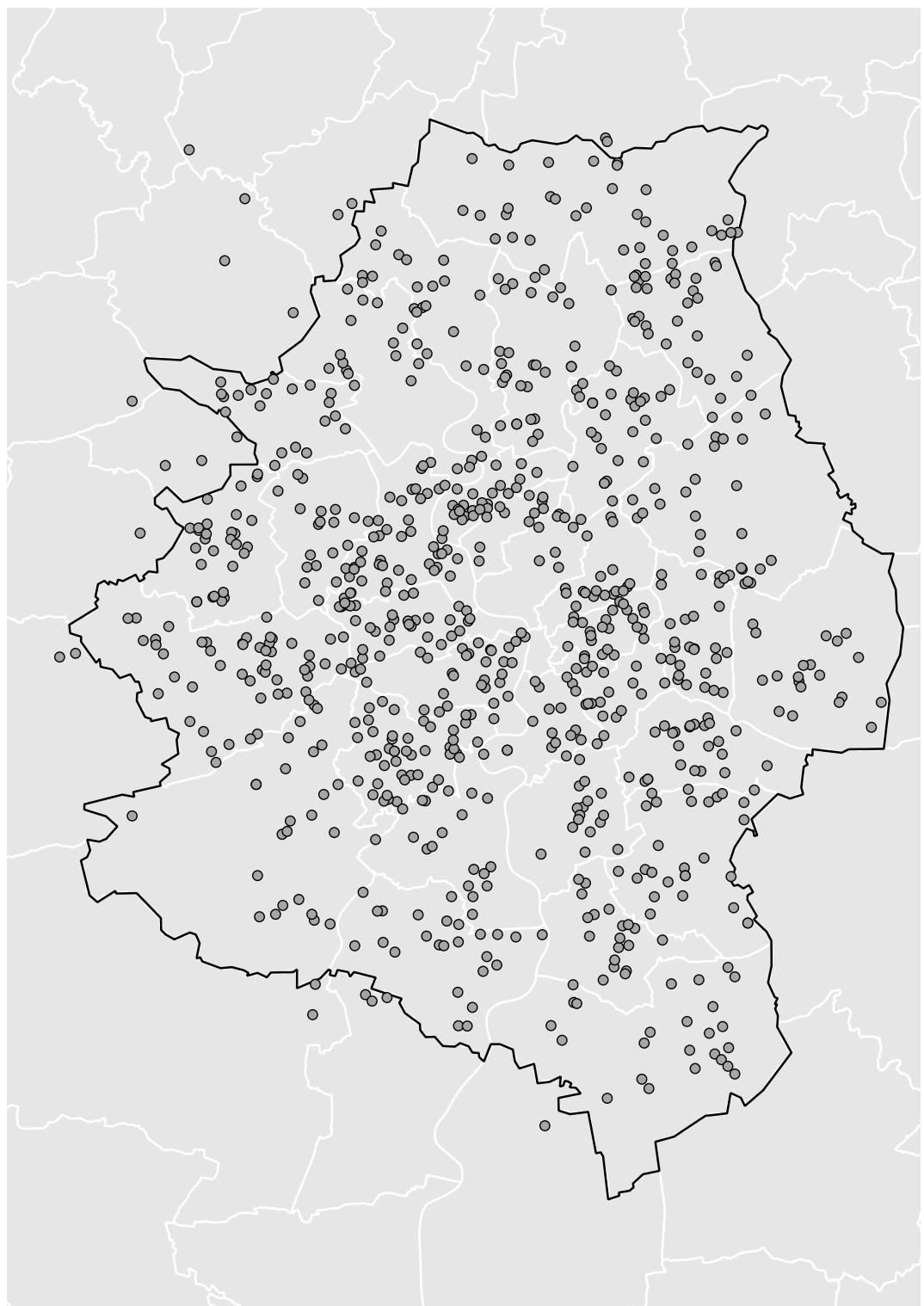


Figure 7.5: Response locations, London web survey

Table 7.4: Spatial variable descriptives, London web survey data

	<i>Mean</i>	<i>Std. dev.</i>	<i>Min.</i>	<i>Max.</i>
<i>% within 3km radius</i>				
LCM green spaces	19.98	14.42	0.99	92.91
OSM green spaces	10.72	6.47	0.00	47.88
OSM parks	8.14	5.67	0.00	43.21
GiGL open spaces	21.41	11.92	0.00	73.22
Freshwater, wetlands and floodplains	1.59	3.00	0.00	25.69
GLA area of (green space) deficiency	0.24	0.43	0.00	1.00
Annual average PM10 level ($\mu\text{g}/\text{m}^3$)	19.27	1.15	17.68	28.22
Annual average NO ₂ level ($\mu\text{g}/\text{m}^3$)	36.28	5.73	25.59	77.29
LHR noise, $L_{\text{eq}} < 57 \text{ dB(A)}$	0.98	0.13	0.00	1.00
Road noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.71	0.45	0.00	1.00
Rail noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.94	0.25	0.00	1.00
Distance from Zone 1, ln(m)	8.84	1.47	0.00	13.19
Distance to Tube or railway station, ln(m)	6.40	0.73	3.29	8.97
Distance to railway line, ln(m)	6.06	1.05	2.80	8.97
Total notifiable offences (LSOA, per 1,000 pop.)	103.69	98.54	15.67	1352.38†
Residential burglaries (LSOA, per 1,000 households)	20.62	12.28	1.01	72.23
Violence against the person (LSOA, per 1,000 pop.)	22.49	22.09	0.63	325.40†
Pop. density (in LSOA, people/ha)	86.20	56.48	0.42	394.29
Pop. density (in km ² , people/ha)	69.29	33.91	0.60	179.16
House price (std. LSOA mean)	0.57	0.31	-0.54	1.78
House price (std. local median)	0.39	0.27	-0.50	1.25

† High maximum crime values are associated with LSOAs having high levels of tourism and/or many entertainment venues, such as Westminster, Soho and Camden Town.

Table 7.5: Spatial variable correlations, London web survey data

	Annual average PM10 level (ug/m3)	Annual average PM10 level (ug/m3)
Annual average NO2 level (ug/m3)	0.94 1.00	
LCM green spaces^	-0.40 -0.51 1.00	
OSM green spaces^	-0.15 -0.17 0.45 1.00	
OSM parks^	0.01 0.04 0.09 0.78 1.00	
GiGL open spaces^	-0.30 -0.37 0.78 0.44 0.15 1.00	
GLA area of deficiency	0.01 0.05 -0.23 -0.29 -0.18 -0.26 1.00	
Freshwater, wetlands and floodplains^	0.16 0.19 -0.17 0.00 0.06 -0.02 0.01 1.00	
LHR noise, Leq < 57 dB(A)	0.03 0.03 -0.11 -0.01 -0.04 0.04 -0.02 0.03 1.00	
Road noise, Lden < 55 dB(A)	-0.42 -0.35 -0.03 0.04 0.03 0.01 0.08 0.05 0.06 1.00	
Rail noise, Lden < 55 dB(A)	0.03 0.01 -0.04 0.02 0.04 -0.03 -0.03 0.03 -0.02 0.00 1.00	
Distance from Zone 1, ln(m)	-0.51 -0.63 0.50 0.17 -0.03 0.36 -0.13 -0.28 -0.07 0.03 -0.04 1.00	
Distance to Tube/station, ln(m)	-0.28 -0.33 0.43 0.15 0.00 0.30 -0.05 -0.06 -0.01 0.03 0.07 0.34 1.00	
Distance to railway line, ln(m)	-0.16 -0.21 0.33 0.14 0.01 0.21 -0.08 0.02 -0.05 -0.05 0.31 0.15 0.55 1.00	
Total notifiable offences (LSOA, per 1,000 pop.)	0.17 0.21 -0.10 -0.09 -0.01 -0.06 0.06 0.04 -0.09 -0.06 0.03 -0.15 -0.13 -0.04 1.00	
Residential burglaries (LSOA, per 1,000 households)	0.07 0.10 -0.07 -0.05 -0.04 -0.03 0.04 -0.02 0.00 -0.03 -0.02 0.04 -0.05 -0.05 0.09 1.00	
Violence against the person (LSOA, per 1,000 pop.)	0.18 0.23 -0.15 -0.10 0.00 -0.10 0.07 0.01 -0.08 -0.05 0.02 -0.15 -0.14 -0.08 0.92 0.04 1.00	
Pop. density (LSOA, people/ha)	0.34 0.46 -0.58 -0.22 0.01 -0.41 0.09 0.10 0.09 0.04 0.04 -0.56 -0.30 -0.17 -0.01 0.00 0.07 1.00	
Pop. density (km2, people/ha)	0.42 0.55 -0.70 -0.30 -0.03 -0.54 0.16 0.08 0.11 0.01 0.03 -0.57 -0.36 -0.22 0.13 0.12 0.19 0.74 1.00	
House price (std. LSOA mean)	0.33 0.40 -0.24 0.01 0.11 -0.23 -0.01 0.18 0.05 -0.03 0.03 -0.51 -0.28 -0.02 0.03 -0.01 -0.06 0.30 0.34 1.00	
House price (std. local median)	0.14 0.17 -0.07 0.02 0.05 -0.12 0.01 0.12 0.02 0.03 0.02 -0.31 -0.11 0.10 -0.06 -0.06 -0.14 0.15 0.15 0.78 1.00	

Off-diagonal correlation coefficients ≥ 0.5 or ≤ -0.5 are in **boldface**.

^ indicates % within 3km radius.

specification (we drop NO₂ and Total Notifiable Offences). Finally, as seems intuitive, distance from Zone 1 is moderately correlated with air pollution, population density and house prices, and some green space measures are moderately correlated with air pollution and/or population density.

7.1.4 Control variables

Descriptive statistics for all control variables used in the regression models are given in Table 7.6.

7.2 Analysis

Except where otherwise noted, all spatial quantities are calculated in relation to respondents' home locations.

7.2.1 Life satisfaction and the environment near the home

We first consider regression models with the single-item 0 – 10 LS response as the dependent variable, and as independent variables a variety of environmental indicators alongside spatial and non-spatial controls.

7.2.1.1 UK

Table 7.7 presents three models for the UK, differing only in the set of land cover proportion measures used⁴. There is one model for each of the simple (unweighted or uniform kernel-weighted) proportion measures described in subsubsection 6.1.2.6. We also estimated models using Gaussian kernel-weighted proportion measures. Since the estimates were very similar to those using simple proportions, but the coefficients are less easy to interpret, they are not shown.

As noted in subsection 6.2.1 the models are estimated by OLS, but we have checked that the results are comparable with those of ordered models. As an example, estimates of the 3km radius model in Table 7.7 by ordered probit are provided in section D.4 of Appendix D.

Control variables The coefficients on the non-spatial control variables vary little between the three models, and are fully in line with the standard findings (discussed in subsection 2.5.2).

Coefficients on the two health dummy variables are highly significant, of large magnitude, and have the expected signs. The classic U-shaped relationship between age and LS is present and highly significant. It is graphed in Figure 7.6. Gender has no significant association with LS, as is usual.

As is also usual, unemployment and living alone⁵ both have large and significant negative associations with LS, while religious belief has a large and significant positive effect.

Income and LS show a highly significant positive relationship. The magnitude of the coefficient is such that, across the full range of incomes seen in the sample, predicted LS ratings would vary by 1.8 points (0.85 standard deviations) on the 0 – 10 scale⁶.

Finally, LS is significantly higher where the respondent's accommodation is rented from a local authority or housing association. This effect is in the expected direction, since such rents might be at below-market rates, allowing for a higher effective income⁷.

⁴Standardised coefficients for these models are provided in Table D.5 in Appendix D.

⁵Living alone is used as a proxy for marital/relationship status, on which data was unfortunately not collected, as noted in subsubsection 4.2.2.3.

⁶In alternative specifications (not shown), an indicator of owning one's home outright — with no mortgage — was included as a measure of wealth. This coefficient on this variable was highly significant ($p < 0.001$) and also of considerable magnitude (0.56 – 0.57). However, the inclusion of this variable does not materially alter any of the other results obtained.

⁷We note, however, that the coefficient on a public housing dummy is significant and *negative* in the study by Brereton et al. (2008), who do not offer any explanation for this.

Table 7.6: Non-spatial regression variable descriptives, all survey data

	% of 1s	Mean	Std. dev.	Min.	Max.
<i>UK survey</i>					
Poor health	27%				
Good health	39%				
Social tenant†	17%				
Equivalised household income, ln(£) *†		9.59	0.79	6.71	12.61
Male	49%				
Age*		46.70	16.06	18	87.5
Age squared		2438.48	1508.02	324.00	7656.25
Unemployed	6%				
Lives alone	19%				
Religious^	30%				
Commuting time*		27.02	19.88	7.5	75
<i>London survey</i>					
Poor health	38%				
Good health	16%				
Social tenant†	22%				
Equivalised household income, ln(£) *†		9.74	0.88	6.6	12.26
Male	46%				
Age*		43.05	16.26	18	87.5
Age squared		2117.53	1488.54	324	7656.25
Degree	44%				
Unemployed	9%				
Not in a relationship	38%				
Divorced or separated	13%				
Religious^	33%				
Commuting time*		37.28	23.05	7.5	75
Long working hours•	15%				

† Dummy indicating respondent rents accommodation from local authority or housing association.

* Taken as the midpoint of the respondent's selected bracket.

† Equivalised by dividing by a household size factor of $\sqrt{a + 0.7c}$,

where a is the number of adults and c the number of children in the household.

^ Dummy indicating respondent answers 6 or higher on the 0 – 10 religious belief item.

• Dummy indicating respondent works a 48-hour week (or longer) more than once a month.

Table 7.7: Basic life satisfaction OLS regressions, UK

Variable	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.					
<i>% LCM NEA category within...</i>											
			<i>1km</i>			<i>3km</i>			<i>10km</i>		
Marine and coastal margins	0.0036	(0.0090)	0.014	(0.010)	-0.0014	(0.010)					
Freshwater, wetlands and floodplains	0.033*	(0.016)	0.044*	(0.021)	0.044+	(0.026)					
Mountains, moors and heathlands	0.0074	(0.0096)	-0.018	(0.021)	0.0025	(0.014)					
Semi-natural grasslands	0.0086+	(0.0049)	0.017**	(0.0062)	0.022**	(0.0075)					
Enclosed farmland	-0.00022	(0.0033)	0.0051	(0.0036)	0.0032	(0.0036)					
Woodland	0.0026	(0.0060)	0.017*	(0.0073)	-0.0081	(0.0079)					
Suburban/rural developed	0.0039+	(0.0023)	0.0054	(0.0034)	0.0038	(0.0053)					
Inland bare ground	0.0091	(0.014)	-0.013	(0.023)	-0.033	(0.039)					
<i>Distance, ln(m)</i>											
National Park	-0.021	(0.036)	-0.0035	(0.036)	-0.021	(0.036)					
AONB	0.0013	(0.030)	0.016	(0.031)	-0.0079	(0.031)					
NNR	0.047	(0.059)	0.049	(0.059)	0.038	(0.058)					
Coast	0.011	(0.031)	0.00092	(0.032)	-0.011	(0.034)					
River	-0.020	(0.041)	-0.0055	(0.041)	-0.012	(0.042)					
Motorway	0.032	(0.035)	0.037	(0.036)	0.027	(0.038)					
Railway station	-0.023	(0.048)	-0.026	(0.048)	-0.021	(0.047)					
Pop. density (km^2 , people/ha)	0.0024	(0.0025)	0.0058*	(0.0026)	0.0025	(0.0024)					
House price (std. local median)	-0.051	(0.14)	-0.11	(0.14)	-0.024	(0.15)					
Poor health	-1.38***	(0.12)	-1.38***	(0.12)	-1.38***	(0.12)					
Good health	0.82***	(0.095)	0.81***	(0.094)	0.81***	(0.095)					
Social tenant	0.28*	(0.13)	0.28*	(0.13)	0.30*	(0.13)					
Equivalised household income, $\ln(\text{£})$	0.30***	(0.065)	0.30***	(0.064)	0.30***	(0.064)					
Male	-0.096	(0.088)	-0.088	(0.087)	-0.096	(0.087)					
Age	-0.075***	(0.018)	-0.073***	(0.018)	-0.075***	(0.018)					
Age squared	0.00100***	(0.00019)	0.00098***	(0.00019)	0.00100***	(0.00019)					
Unemployed	-1.16***	(0.21)	-1.12***	(0.20)	-1.13***	(0.21)					
Lives alone	-0.61***	(0.12)	-0.60***	(0.12)	-0.61***	(0.12)					
Religious	0.40***	(0.094)	0.41***	(0.094)	0.39***	(0.094)					
Constant	3.95***	(1.15)	3.09*	(1.20)	4.19***	(1.22)					
Observations	1848			1848							
Adjusted R-squared	26.0%			26.4%							

Dependent variable: life satisfaction self-rating, 0 – 10.

Standard errors are sandwich estimators.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

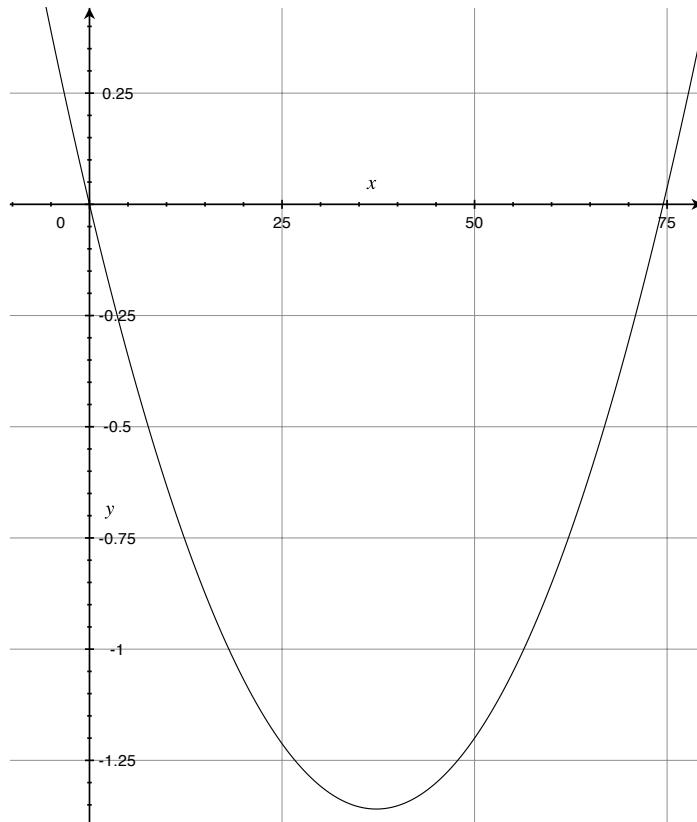


Figure 7.6: The U-shaped relationship between age (x) and LS (y): $y = -0.073x + 0.00098x^2$

Land cover In each model, eight land cover proportion variables are entered. The omitted land cover type is ‘continuous urban’, so the coefficients can be interpreted as describing the variation in LS as the share of a given type is increased, while decreasing the share of continuous urban land cover.

Coefficients (and their p values) on the land cover proportions vary across the three scales considered. The coefficient on freshwater is positive and significant in the models with proportions over a 1km and 3km radius. The coefficient on grasslands is positive and significant in the 3km and 10km radius models. The coefficient on woodlands is positive and significant only in the 3km radius model. No other land cover coefficient is significantly different from zero at the 5% level in any model⁸. Since it has the greatest number of significant coefficients the 3km radius model is our preferred model, and the one we use for purposes of monetary valuation below.

The significant land cover coefficients in the 3km radius model — on freshwater, grasslands and woodland — are of fairly large magnitude. The explanatory variables are scaled as percentages, so the coefficients tell us much how the predicted 0 – 10 LS scale value would change for every 1% increase in the relevant land cover type. There are approximately 2,800ha of land within a 3km radius, so an increase of 1% in the proportion of a given land cover type corresponds to the addition of 28ha of that type.

Turning these figures around, how big a change in each land cover type would increase the predicted 0 – 10 LS rating by 1 point? Freshwater would need to cover an additional 23% or 641ha; grasslands would need to cover an extra 58% or 1,652ha; and woodland would need to cover 57% or 1,623ha more. As might be expected, these are very large changes — equivalent to several standard deviations in each case — but they are not outside the total ranges of the values seen in the sample (Table 7.2).

Other spatial variables We include distance variables both as indicators of the availability of natural environments (National Parks, AONBs, NNRs, coastline and rivers) and as proxies

⁸In the models discussed, the land cover proportion variables are entered as simple percentages. In alternative models (not shown) they were entered as logs; in these models, no coefficient was significantly different from zero at the 5% level.

for local amenities which may affect wellbeing and/or house prices (motorways and stations). However, no coefficient on any of these variables is significantly different from zero.⁹

As an additional control for local characteristics and amenities we include a measure of local population density (in the 1km grid square containing the respondent's home). In the 3km radius model only, the coefficient on this measure is significantly positive. As noted previously, we also include an indicator of house prices, which should allow us to estimate total values for the EQ characteristics. The coefficient on this variable is not significant in any specification.¹⁰

7.2.1.2 London

For the London data we again present three models differing in the area proportion measures used. These models are shown in Table 7.8.¹¹ As in the UK case there is one model for each of the simple proportion measures calculated. Again, we also estimated models using Gaussian kernel-weighted proportions; again, these are very similar and we do not report them.

Control variables Coefficients on the non-spatial control variables follow exactly the same pattern (and have broadly similar magnitudes) as those in the UK models discussed above. The sole exception is the coefficient on renting accommodation from a council or housing association, which in these models is not significant. We are not certain of the explanation for this, save that the London housing market may have a distinctive structure.

Green and blue space The models shown use the LCM-based green space proportion indicators. No coefficient on these variables is significantly different from zero at any of the three radii considered. We also estimated alternative models (not shown) in which we substituted proportion measures calculated from the OSM green space, OSM parks and GiGL open space data sets, and one in which we used the GiGL 'Area of Deficiency' dummy variable. Again, no coefficient was significant at any radius.

The LCM blue space proportion indicator was also not significantly different from zero over any radius.

Air pollution, noise, crime and control variables None of the other coefficients on spatial variables are significantly different from zero.

The results in these models are not substantially altered if we omit either or both of the distance variables that are included as controls, replace distance to Zone 1 with either of the population density measures (with which it is substantially correlated), or use the LSOA-level house price indicator.

7.2.2 Alternative happiness indicators

We now consider the sensitivity of our findings to the use of alternative SWB measures. For both the UK and London data we estimate models with the same explanatory variables as above. We limit ourselves to proportion variables calculated over a 3km radius only.

⁹In the models discussed here, all distances are entered in logs. They were entered as simple distances in alternative models (not shown), but still no coefficient was significant in any specification.

¹⁰Alternative specifications were tried (not shown) omitting either or both of the population density and house price variables, or replacing them with their LSOA-level equivalents. Only specifications in which no population density indicator was included produced appreciably different results. In these specifications, the coefficients on the three significant land cover types were slightly reduced, with the coefficient on woodland just losing significance at the 5% level ($p < 0.09$) in the model using proportions within 3km.

Further alternative specifications were run (not shown) in which we also included latitude, longitude, country dummies (for Wales, Scotland, and Northern Ireland), and climate variables. Latitude and longitude were included to account for variation in the hours of daylight and the potentially depressing effect of getting up in the dark. Country dummies were included to check for geographical stability. The climate variables used were calculated from the UK Climate Projections (UKCP09) 5km gridded monthly observation data sets made available by the Met Office, and were means for 2001 – 2006 of: air temperature (°C); sunshine duration (hours/day); total precipitation (mm/month); wind speed (knots); and snow lying (days/month). None of the coefficients on these additional spatial variables were significant at the 5% level. The coefficients on land cover type variables were slightly reduced in both magnitude and significance when the additional variables were included, but the overall pattern remained highly similar.

¹¹Standardised coefficients for the models are provided in Table D.6 in Appendix D.

Table 7.8: Basic life satisfaction OLS regressions, London

Variable	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
% green or blue space within...						
LCM green space	-0.0020	(0.0040)	-0.0082	(0.0051)	0.0027	(0.0070)
LCM freshwater, wetlands and floodplains	0.0024	(0.011)	-0.040+	(0.021)	-0.0025	(0.027)
Annual average PM10 level ($\mu\text{g}/\text{m}^3$)	0.071	(0.084)	0.065	(0.085)	0.082	(0.086)
LHR noise, $L_{\text{eq}} < 57 \text{ dB(A)}$	-0.79+	(0.44)	-0.79+	(0.43)	-0.77+	(0.44)
Road noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.077	(0.17)	0.069	(0.17)	0.096	(0.17)
Rail noise, $L_{\text{den}} < 55 \text{ dB(A)}$	-0.19	(0.33)	-0.19	(0.33)	-0.17	(0.33)
Distance from Zone 1, ln(m)	0.061	(0.10)	0.071	(0.11)	0.049	(0.11)
Distance to Tube/station, ln(m)	-0.11	(0.098)	-0.051	(0.10)	-0.12	(0.10)
Residential burglaries (LSOA, per 1,000 hhs.)	0.0066	(0.0048)	0.0057	(0.0048)	0.0066	(0.0048)
Violence against the person (LSOA, per 1,000 pop.)	-0.0012	(0.0041)	-0.0014	(0.0041)	-0.0011	(0.0041)
House price (std. local median)	0.22	(0.28)	0.28	(0.27)	0.21	(0.28)
Poor health	-1.23***	(0.15)	-1.25***	(0.15)	-1.23***	(0.15)
Good health	0.78***	(0.17)	0.77***	(0.17)	0.78***	(0.17)
Social tenant	0.0012	(0.18)	0.0050	(0.18)	0.0038	(0.18)
Equivalised household income, ln(£)	0.41***	(0.088)	0.41***	(0.087)	0.41***	(0.087)
Male	0.13	(0.14)	0.13	(0.14)	0.13	(0.14)
Age	-0.10***	(0.025)	-0.10***	(0.025)	-0.10***	(0.025)
Age squared	0.0012***	(0.00027)	0.0013***	(0.00027)	0.0012***	(0.00026)
Degree	-0.23	(0.14)	-0.23+	(0.14)	-0.23	(0.14)
Unemployed	-1.03***	(0.28)	-1.03***	(0.27)	-1.03***	(0.28)
Not in a relationship	-0.28*	(0.14)	-0.28*	(0.14)	-0.27+	(0.14)
Divorced or separated	-0.069	(0.23)	-0.067	(0.23)	-0.070	(0.23)
Religious	0.55***	(0.15)	0.56***	(0.15)	0.56***	(0.15)
Constant	3.92	(2.55)	3.77	(2.54)	3.82	(2.54)
Observations	810		810		810	
Adjusted R-squared	25.1%		25.7%		25.1%	

Dependent variable: life satisfaction self-rating, 0 – 10.
 Standard errors are sandwich estimators clustered at LSOA level.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7.2.2.1 Emotional wellbeing and affect measures

Using the UK data we substitute for the 0 – 10 life satisfaction item three alternative dependent variables: the emotional wellbeing sub-scale of the SF-36, and the positive and negative components of the PANAS. The resulting model estimates are presented in [Table 7.9](#). The EQ and spatial coefficient estimates follow a quite different pattern from those obtained using the life satisfaction score.¹²

SF-36 emotional wellbeing In the emotional wellbeing model, the only spatial regressor with a coefficient significantly different from zero is the proportion of farmland within 3km, which is positively associated with wellbeing. This regressor did not have a significant relationship with the 0 – 10 life satisfaction item.

The size of the effect is substantially smaller than in the case of the EQ variables discussed in [subsubsection 7.2.1.1](#) (the coefficient is of a similar order of magnitude, but the range and standard deviation of the dependent variable are an order of magnitude larger).

PANAS positive affect The positive PANAS component also has only one significant spatial predictor, which in this case is the distance to the nearest motorway. The coefficient is positive, so living *further* from a motorway results in higher predicted positive affect.

PANAS negative affect Higher values on the PANAS negative affect scale indicate lower levels of wellbeing, so the signs on the coefficients have the opposite interpretation in this model compared to the others.

Three EQ variables have a significant association with the dependent variable. As in the emotional wellbeing model, local farmland is positively related to wellbeing. A higher local share of suburban or rural developed land, and closer proximity to the nearest river, are both also associated with greater wellbeing.

7.2.2.2 Multi-item general wellbeing scales

Using the London data we estimate models having as their dependent variables three different aggregated scales from the ESS Wellbeing Module: a multi-item life satisfaction scale, and two more wide-ranging scales (of which the life satisfaction scale is in each case a part) aggregating respectively personal, and both personal and social, wellbeing items. These models are presented in [Table 7.10](#).

As was also the case when using the basic life satisfaction scale with the London data, no EQ parameter coefficient is significant (at the 5% level) in any of the three models. As in [subsubsection 7.2.1.2](#) the models we report include green space proportion measures based on LCM types, but we also estimated models using variables calculated using the four OSM and GiGL data sets, and these produced qualitatively indistinguishable results.

One spatial control variable does have a significant coefficient in all three models, however: the residential burglary rate is in each case positively associated with wellbeing. This result is certainly not intuitive, but could relate to unobserved spatial correlates of the burglary rate.

7.2.3 The environment near the workplace

Finally, we investigate whether EQ characteristics in the vicinity of respondents' workplaces have a measurable association with LS. Sample sizes are substantially reduced in these models, since they include only respondents who are employed and — in the London survey — work within London.

Models estimated from UK and London data are displayed in [Table 7.11](#) and [Table 7.12](#) respectively. In each case, no workplace EQ variable has a significant coefficient.

¹²Coefficients on control variables are also a little different in some cases, but since they are not of primary interest we do not discuss them here.

Table 7.9: Aggregate dependent variable OLS regressions, UK

Dependent variable ►	SF-36 emotional wb.		PANAS positive affect		PANAS negative affect^	
Variable ▼	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
<i>% LCM NEA category within 3km</i>						
Marine and coastal margins	0.12	(0.11)	0.025	(0.045)	-0.055	(0.053)
Freshwater, wetlands and floodplains	0.24	(0.19)	0.13	(0.090)	-0.12	(0.074)
Mountains, moors and heathlands	-0.21	(0.24)	-0.14	(0.083)	0.012	(0.084)
Semi-natural grasslands	0.0015	(0.064)	0.022	(0.027)	-0.021	(0.025)
Enclosed farmland	0.071*	(0.035)	0.0063	(0.015)	-0.047***	(0.014)
Woodland	0.075	(0.081)	0.038	(0.032)	-0.029	(0.033)
Suburban/rural developed	0.012	(0.034)	0.0044	(0.014)	-0.039**	(0.014)
Inland bare ground	-0.15	(0.23)	0.056	(0.093)	-0.031	(0.086)
<i>Distance, ln(m)</i>						
National Park	-0.0081	(0.31)	-0.0066	(0.13)	-0.069	(0.14)
AONB	0.098	(0.33)	0.10	(0.13)	-0.0073	(0.12)
NNR	-0.24	(0.63)	-0.20	(0.26)	0.16	(0.24)
Coast	0.37	(0.31)	0.15	(0.13)	-0.034	(0.13)
River	-0.64	(0.40)	-0.080	(0.17)	0.42*	(0.17)
Motorway	0.018	(0.35)	0.31*	(0.15)	-0.018	(0.15)
Railway station	-0.13	(0.48)	-0.074	(0.20)	0.085	(0.19)
Pop. density (km ² , people/ha)	0.049+	(0.026)	0.0071	(0.012)	-0.023+	(0.012)
House price (std. local median)	-1.40	(1.38)	0.19	(0.60)	0.51	(0.57)
Poor health	-12.9***	(1.18)	-5.60***	(0.47)	3.99***	(0.50)
Good health	10.1***	(0.97)	4.80***	(0.43)	-2.75***	(0.38)
Social tenant	0.79	(1.21)	0.22	(0.52)	0.19	(0.52)
Equivalised household income, ln(£)	2.61***	(0.61)	0.76**	(0.26)	-1.06***	(0.26)
Male	2.38**	(0.87)	0.38	(0.37)	-0.87*	(0.35)
Age	-0.22	(0.17)	-0.057	(0.074)	-0.11+	(0.066)
Age squared	0.0066***	(0.0017)	0.0015+	(0.00078)	-0.00045	(0.00069)
Unemployed	1.57	(1.88)	-0.25	(0.86)	-1.00	(0.80)
Lives alone	-3.41**	(1.14)	-1.21*	(0.48)	-0.062	(0.45)
Religious	-1.31	(0.96)	1.39***	(0.40)	1.09**	(0.39)
Constant	30.4**	(11.8)	16.8***	(4.82)	36.0***	(4.89)
Observations	1848		1848		1848	
Adjusted R-squared	26.1%		24.7%		19.0%	

Standard errors are sandwich estimators.

[^] Since the dependent variable is *negative affect* the signs of the coefficients have the opposite interpretation in this model.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7.10: ESS aggregate indicator OLS regressions, London

Dependent variable ►	Satisfying life		Personal wellbeing		Personal & social wb.	
Variable ▼	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
<i>% green or blue space within 3km</i>						
LCM green space	-0.00058	(0.0027)	-0.00068	(0.0019)	-0.00062	(0.0016)
LCM freshwater, wetlands and floodplains	-0.0040	(0.010)	-0.0063	(0.0089)	-0.0041	(0.0075)
Annual average PM10 level ($\mu\text{g}/\text{m}^3$)	-0.0047	(0.035)	-0.0080	(0.024)	-0.0048	(0.021)
LHR noise, $L_{\text{eq}} < 57 \text{ dB(A)}$	-0.24	(0.21)	-0.19	(0.12)	-0.19+	(0.096)
Road noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.034	(0.068)	0.043	(0.048)	0.056	(0.042)
Rail noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.0033	(0.12)	0.11	(0.12)	0.051	(0.096)
Distance from Zone 1, ln(m)	0.038	(0.041)	0.023	(0.025)	0.010	(0.023)
Distance to Tube/station, ln(m)	-0.042	(0.041)	-0.045	(0.029)	-0.020	(0.026)
Residential burglaries (LSOA, per 1,000 hhs.)	0.0042*	(0.0020)	0.0037*	(0.0015)	0.0037**	(0.0013)
Violence against the person (LSOA, per 1,000 pop.)	-0.0015	(0.0018)	-0.00049	(0.0011)	-0.00054	(0.0010)
House price (std. local median)	0.17	(0.11)	0.018	(0.075)	0.029	(0.066)
Poor health	-0.52***	(0.060)	-0.56***	(0.043)	-0.45***	(0.037)
Good health	0.32***	(0.074)	0.33***	(0.051)	0.27***	(0.046)
Social tenant	0.014	(0.073)	0.014	(0.050)	-0.0086	(0.045)
Equivalised household income, ln(£)	0.20***	(0.036)	0.11***	(0.025)	0.10***	(0.022)
Male	0.037	(0.054)	0.068+	(0.039)	0.031	(0.034)
Age	-0.043***	(0.0095)	-0.016*	(0.0070)	-0.015*	(0.0060)
Age squared	0.00052***	(0.00010)	0.00024**	(0.000075)	0.00023***	(0.000065)
Degree	-0.056	(0.056)	-0.0056	(0.039)	0.0036	(0.034)
Unemployed	-0.32**	(0.10)	-0.19**	(0.072)	-0.14*	(0.061)
Not in a relationship	-0.21***	(0.056)	-0.12**	(0.041)	-0.14***	(0.035)
Divorced or separated	0.011	(0.091)	0.0093	(0.065)	0.055	(0.057)
Religious	0.19***	(0.058)	0.12**	(0.042)	0.13***	(0.035)
Constant	-0.87	(0.99)	-0.46	(0.67)	-0.57	(0.59)
Observations	809		805		805	
Adjusted R-squared	28.7%		37.0%		35.7%	

Standard errors are sandwich estimators clustered at LSOA level.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7.11: Life satisfaction OLS regression including workplace NEA indicators, UK

Variable	Coeff.	Std. err.
<i>% LCM NEA category within 3km of workplace</i>		
Marine and coastal margins	-0.022	(0.018)
Freshwater, wetlands and floodplains	-0.0021	(0.023)
Mountains, moors and heathlands	0.035	(0.030)
Semi-natural grasslands	-0.0077	(0.0096)
Enclosed farmland	0.0023	(0.0036)
Woodland	-0.0063	(0.0095)
Suburban/rural developed	-0.0039	(0.0034)
Inland bare ground	-0.0099	(0.024)
Commuting time (minutes)	-0.0058*	(0.0029)
<i>% LCM NEA category within 3km of home</i>		
Marine and coastal margins	0.026+	(0.015)
Freshwater, wetlands and floodplains	0.037	(0.032)
Mountains, moors and heathlands	-0.041	(0.034)
Semi-natural grasslands	0.021*	(0.0086)
Enclosed farmland	0.0053	(0.0052)
Woodland	0.024*	(0.0094)
Suburban/rural developed	0.0048	(0.0043)
Inland bare ground	0.0090	(0.032)
<i>Distance from home, ln(m)</i>		
National Park	-0.0043	(0.061)
AONB	0.024	(0.040)
NNR	0.018	(0.074)
Coast	-0.030	(0.043)
River	0.069	(0.055)
Motorway	-0.042	(0.047)
Railway station	-0.031	(0.064)
Pop. density (km^2 , people/ha)	0.0050	(0.0036)
House price (std. local median)	-0.078	(0.19)
Poor health	-1.20***	(0.19)
Good health	0.95***	(0.12)
Social tenant	0.18	(0.18)
Equivalised household income, ln(£)	0.35***	(0.092)
Male	0.0016	(0.12)
Age	-0.10***	(0.024)
Age squared	0.0013***	(0.00026)
Unemployed	-0.43	(0.48)
Lives alone	-0.77***	(0.17)
Religious	0.39**	(0.12)
Constant	4.16*	(1.72)
Observations	994	
Adjusted R-squared	23.4%	

Dependent variable: life satisfaction self-rating, 0 – 10.

Standard errors are sandwich estimators.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7.12: Life satisfaction OLS regression including workplace EQ indicators, London

Variable	Coeff.	Std. err.
<i>% green or blue space within 3km of workplace</i>		
LCM green space	-0.0091	(0.0086)
LCM freshwater, wetlands and floodplains	0.013	(0.027)
<i>Air pollution and noise at workplace location</i>		
Annual average PM10 level ($\mu\text{g}/\text{m}^3$)	0.0063	(0.038)
LHR noise, $L_{\text{eq}} < 57 \text{ dB(A)}$	-0.85	(0.65)
Road noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.11	(0.20)
Rail noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.044	(0.46)
<i>Commuting time (minutes)</i>		
Long working hours	-0.0016	(0.0047)
<i>Long working hours</i>		
<i>% green or blue space within 3km of home</i>		
LCM green space	0.0093	(0.0097)
LCM freshwater, wetlands and floodplains	-0.025	(0.041)
<i>Air pollution and noise at home</i>		
Annual average PM10 level ($\mu\text{g}/\text{m}^3$)	0.10	(0.13)
LHR noise, $L_{\text{eq}} < 57 \text{ dB(A)}$	0.22	(1.13)
Road noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.20	(0.25)
Rail noise, $L_{\text{den}} < 55 \text{ dB(A)}$	-0.82**	(0.31)
<i>Other spatial variables for home</i>		
Distance from Zone 1, ln(m)	-0.042	(0.13)
Distance to Tube/station, ln(m)	-0.31*	(0.14)
Residential burglaries (LSOA, per 1,000 hhs.)	0.0064	(0.0082)
Violence against the person (LSOA, per 1,000 pop.)	-0.0026	(0.0058)
House price (std. local median)	0.059	(0.37)
Poor health	-1.17***	(0.23)
Good health	0.37	(0.26)
Social tenant	0.28	(0.26)
Equivalised household income, ln(£)	0.36**	(0.12)
Male	0.14	(0.19)
Age	-0.091**	(0.034)
Age squared	0.0011**	(0.00039)
Degree	-0.12	(0.21)
Unemployed	-1.52**	(0.57)
Not in a relationship	-0.17	(0.20)
Divorced or separated	-0.24	(0.33)
Religious	0.41*	(0.20)
Constant	5.99	(3.88)
Observations	363	
Adjusted R-squared	15.9%	

Dependent variable: life satisfaction self-rating, 0 – 10.

Standard errors are sandwich estimators clustered at LSOA level.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7.13: Implicit prices at mean income for significant EQ characteristics in UK models

SWB indicator	EQ parameter	Implicit price (£/1%/year)	Implicit price from models excluding health status (£/1%/year)
Life satisfaction	% freshwater, wetlands and floodplains within 3km	2813*	1720*
	% semi-natural grasslands within 3km	1093*	718*
	% woodland within 3km	1109*	665*
SF-36 emotional wellbeing	% farmland within 3km	521+	199

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In these models we also control for respondents' commuting time and — for the London survey — an indicator of long working hours. Longer commuting times bring significantly lower predicted LS in the UK model (equivalent to approximately one-third of a point on the 0 – 10 scale per travelling hour). Neither variable has a significant coefficient in the London model, however.

7.2.4 Robustness checks

We have already described a number of checks on the robustness of our results to variations in model specification, as appropriate to the particular models being run.

Finally, to check for multicollinearity, we calculate the Variance Inflation Factor (VIF) for each explanatory variable in the regression models we report. Except in the case of age and age squared — which necessarily account for much of each other's variation — no VIF is greater than 3.5, and almost all are less than 2. Common rules-of-thumb for identifying multicollinearity problems suggest VIF thresholds of 4, 5 or 10 (O'Brien, 2007), which we fall safely below.

7.2.5 Valuation

As discussed in subsection 2.2.3, SWB models of the type estimated above may be used for monetary valuation. The scope for using our results for this purpose is limited, however, since for most EQ variables the estimated wellbeing effects are not significantly different from zero.

Implicit prices for EQ characteristics that do have significant effects are shown in the third column of Table 7.13. These are the marginal rates of substitution (MRS) between the EQ characteristics and income, at the mean income, calculated according to Equation (2.1) in subsubsection 2.2.3.1. The life satisfaction model from which the freshwater, grassland and woodland implicit prices are estimated is the 3km radius model reported in Table 7.7. The SF-36 emotional wellbeing model from which the implicit price on farmland is calculated is the first model presented in Table 7.9.

The values reported are annual values of a 1% (28ha) change in land cover type within 3km, matched by an oppositely-signed change in the continuous urban type. Since we include both house price indicators and income in our model specifications, we can interpret these values as the full values of the relevant EQ features¹³.

These values seem too high. For example, using Equation (2.2) in subsubsection 2.2.3.1 to calculate compensating surpluses reveals that, at the mean income (£19,204), respondents would be willing to pay an amount equal to half that mean income for an increase of just under 5% (141ha) in freshwater land cover within 3km. As noted in subsubsection 2.2.3.3, implausibly large value estimates are a widespread problem in previous research. For example, from their

¹³However, since dropping house price indicators from the regressions does not much reduce the coefficients on EQ variables, it would seem — perhaps implausibly, in the light of what is known from hedonic pricing studies — that variations in the EQ characteristics considered are mainly uncompensated through the housing market.

'baseline' model Ferreira & Moro (2010) calculate MRS values of €15,585 per 1°C per year for changes in January mean temperature, and of -€945 per $1\mu\text{g}/\text{m}^3$ per year for changes in PM10 concentrations.

7.2.5.1 Correcting the income coefficient

As also noted in [subsubsection 2.2.3.3](#), underestimation of the effect of income has commonly been suggested as the cause of such high values. Our income coefficients seem low even in relation to some others in the literature. For example, in Ferreira & Moro (2010)'s 'baseline' model a one standard deviation change in log income implies a 0.33 standard deviation change in SWB score, while a one standard deviation change in log income in our 3km UK LS model implies only a 0.11 standard deviation change in LS.

Various means of correcting such underestimation have been proposed. Not all of these are possible with the data available to us, but we try three different approaches.

Indirect effects First, it may be that income has indirect positive impacts on SWB mediated by other variables included in the regression models, such as health status indicators ([Dolan et al., 2011](#)). To test this, we estimate alternative models from which we exclude the two health status dummy variables¹⁴. In these models the income coefficient is indeed somewhat increased — for the life satisfaction model it is 0.48, up from 0.30. We present alternative implicit prices calculated from these models in the final column of [Table 7.13](#). These prices are indeed somewhat reduced, but still appear implausibly large (except for the price derived from the emotional wellbeing model, which is no longer significantly different from zero).

Costs of income generation The second correction we attempt is to account for the costs of income generation. We compare the income coefficients in our models that use data on working respondents only ([Table 7.11](#) and [Table 7.12](#)) with coefficients from models that are identical apart from the omission of the variables indicating commuting time and (for London only) habitually long working hours.

This comparison reveals that including the costs of income generation does again inflate the income coefficients somewhat (from 0.31 to 0.35 in the UK model, and from 0.34 to 0.36 for London), but not sufficiently to make a substantial difference to the calculated values.

The self-employed Finally, we follow Luechinger (2009) in estimating our models with self-employed respondents excluded from the sample, on the basis that the self-employed may be more likely to underestimate their incomes. This makes almost no difference at all either to our coefficient estimates, including those on income, or to the mean income, and thus has very little effect on the calculated values.

Instrumental variables To try to correct for the costs of income generation, for possible reverse causality (in which greater happiness leads to higher incomes) and other forms of endogeneity, for measurement error, and for possible problems associated with transient income, a small number of studies in happiness economics have used instruments for income¹⁵. For example: Luttmer (2005) instruments income with the industry \times occupation of the respondent and their spouse; Oswald & Powdthavee (2008) use (non-)observation by the interviewer of the respondent's payslip, and income and regional house prices in the previous period ($t - 1$); Luechinger (2009) uses industry \times occupation of the main income earner who is not the respondent; and Ferreira & Moro (2010) use an ordinal indicator of social class. In general, the coefficients on these instruments are somewhat larger than on a simple income variable, and thus the valuations derived are somewhat smaller.

However, like the majority of the previous literature, we do not instrument income in this study. First, there are significant caveats associated with such use of instrumental variables. As

¹⁴We also try excluding other variables, but only health status makes a substantial difference.

¹⁵Fujiwara & Campbell (2011, p. 29): "A small number of studies in the well-being literature have used instruments for some of the explanatory variables in the life satisfaction equation".

noted in [subsubsection 2.2.3.3](#), predicted income values arguably also represent an estimate of a respondent's comparator income ([Luechinger, 2009](#), p. 493). Since the sign of the effect of comparator income on happiness is expected to be negative (e.g. [Clark & Oswald, 1996](#)), this makes interpretation of the income effect using such instrumental variables problematic. Second, variables typically identified as appropriate instruments — such as industry, occupation, social class, or previous income of the respondent and/or other household members — are not available in our survey data set¹⁶.

7.2.5.2 Alternative SWB indicators

Since we do not find significant coefficients on any of the same EQ variables using alternative wellbeing indicators, we cannot compare the valuations that result. We do note, however, that the three different dependent variables shown in [Table 7.10](#) — which are equivalently scaled, being in each case z-score averages — provide substantially varying income coefficient estimates. The coefficient in the 'satisfying life' model (0.20) is approximately twice as large as those in the models predicting broader wellbeing measures (0.11 and 0.10). This is in line with the previous findings discussed in [subsubsection 2.2.3.3](#).

7.3 Discussion

This chapter has presented results from a more detailed and comprehensive investigation of links between SWB and EQ than has previously been attempted. We include a wide range of EQ characteristics, including some not previously considered; we use spatial and location data at very high resolution, and advanced GIS-based measures, to produce highly accurate EQ indicator variables; we investigate the use of alternative SWB measures; and in each case we do so at two different scales, to make best use of the available spatial data.

7.3.1 Environment and life satisfaction in the UK

At the whole-country level, we find that the prevalence around individuals' homes of some natural land cover types has a significant and substantial positive relationship with LS. These types are: freshwater, wetlands and floodplains; semi-natural grasslands; and woodland. None of the other EQ measurements we investigated were significantly related to LS.

The land cover types with significant coefficients clearly represent types of green and blue spaces. That their effects are positive is therefore in line with our research hypotheses. On the other hand there are other land cover types, also representing green and blue spaces, for which we do not find a significant effect. Our findings thus do not unequivocally support a relationship between LS and green and blue spaces.

We use the significant EQ coefficients, alongside the coefficient on income, to derive monetary values for the relevant green and blue space amenities. Even after applying several corrections, the values remain implausibly high.

7.3.1.1 Robustness

The magnitude of the significant coefficients is large. However, in most cases their *p*-values do not much exceed the customary 5% threshold. We have focused on the model using proportions calculated within a 3km radius, but the model estimates do vary according to the radius chosen, and we have no *a priori* justification for preferring a particular radius. In addition, we estimated a series of models with a variety of explanatory variables, increasing the risk that some coefficients might appear significant by chance, even if the null hypothesis (of no effect on LS) were correct. As noted previously, our results are not sensitive to some variations in specification as regards spatial control variables. In sum, however, they are not as robust as we might wish.

¹⁶In retrospect, one might of course wish that the survey instrument had included such information.

7.3.1.2 The workplace

The positive relationships we identify around the home do not extend to individuals' places of work, nor are there any other significant relationships between LS and nearby EQ for workplace locations. It may be that individuals do not spend a substantial enough proportion of their time in the vicinity of the workplace, or that for other reasons the characteristics of this environment affect wellbeing to a lesser degree¹⁷. Given that our other findings do not seem entirely robust, we would hesitate to claim that this absence of evidence of any link between workplace EQ and LS should be accorded substantial weight as evidence of absence.

7.3.1.3 Comparison with previous findings

The EQ indicators we use here have not, apart from distance to the coast, been included in previous LS studies¹⁸. We therefore look to studies on health and house prices for broad comparative purposes. As outlined in subsection 3.2.3, epidemiological studies have found that green space (generally not further defined or disaggregated) is positively related to general and mental health (e.g. de Vries et al., 2003; Maas et al., 2009). Since health status is a strong predictor of SWB, this seems broadly consistent with our findings.

Also consistent with our results, the hedonic study by Gibbons et al. (2011) finds that freshwater and woodland land cover types are significantly and positively associated with house prices, with freshwater having the largest effect¹⁹. However, they also identify a (smaller) positive link with farmland and a negative relationship with inland bare ground, and find no significant relationship with grassland.

Comparing values calculated for freshwater and woodland land cover between the two studies highlights the implausibility of our estimates, since our *annual* values (even when calculated with the 'upper bound' income coefficient) are approximately twice as large as the *capitalised* house price premiums calculated by Gibbons et al.

We know of no other studies examining EQ around the workplace, so we cannot draw comparisons with these results.

7.3.2 Environment and wellbeing in London

By contrast with our UK-wide results, we find no significant links between LS and EQ characteristics in our London data set.

Regarding noise, previous results are consistent with this: the only known study regressing LS scores on objective noise indicators also finds no significant relationship²⁰ (van Praag & Baarsma, 2005). Unfortunately, for all three of our sources of noise data — road, rail and air — the vast majority of our respondents are classified in the lowest category, giving us little power to detect significant effects²¹.

Local proportions of green and blue space have not previously been investigated in LS research. However, a recent hedonic study in London found substantial positive effects on house prices of local green space and proximity to the Thames (Smith, 2010) and, as noted in the previous section, epidemiological studies elsewhere have also found local green space to be related to better health. The lack of any effect of green space on LS, across several independent data sets and a number of different radii, therefore seems a little surprising.

¹⁷On the other hand, it could be that LS is not directly affected by EQ either at home or at work, but that the effects we pick up for the home location are due to unobserved spatial covariates of EQ that are relevant to the home but not the workplace location.

¹⁸Of the two previous studies addressing distance to coast cited in subsection 3.2.3, one found that proximity was positive, and the other that it had no effect. Our results are consistent with these, in as far as that they do not show proximity to be significantly negative.

¹⁹We compare their 'Model 5: All Great Britain', which is the most similar to ours by specification and geographical extent.

²⁰No significant relationship is found except where perceived scores are instrumented with objective data.

²¹Arguably, these noise data sets could usefully differentiate substantially lower noise levels (for example, the researcher finds aircraft noise in the early mornings a significant nuisance several miles beyond the lowest-level noise contour for Heathrow and City airports).

Even more surprising is the lack of an association between LS and air pollution, since in subsection 3.2.3 we cite 10 studies that find air pollution negatively related to LS — including MacKerron & Mourato (2009), who address the issue using individual-level data in London.

7.3.2.1 Lack of significant findings

Given the contrast with previous research, especially regarding air pollution, the lack of any significant findings requires some explanation. A wide range of explanations could potentially apply, which we address in order of increasing generality.

Data quality It might be that our paid web survey panel did not respond conscientiously to the questions they were asked; in this case, random noise in the data might obscure the patterns we are seeking. However, as described in section 4.6, data quality was thoroughly checked. Furthermore, the non-spatial variables in our London models (such as age, income, unemployment and religion) all have the expected effects, generally at high significance levels.

Sample size The London sample, with around 800 usable response sets, is about half the size of the UK sample, and smaller than some others in the literature: the Irish data set used by Brereton et al. (2008) and others, for example, has about 1,500 usable responses. On the other hand, MacKerron & Mourato's sample is half the size again, at about 400 responses. A larger sample will always enable smaller effects to be revealed, but it is not clear whether this is a problem here.

Specific indicators Different studies of air quality and LS have used data on different pollutants, including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), lead and particulates (PM10). Different statistics may also be used, such as annual average concentrations or the number of days on which a pollutant's concentration exceeds a threshold value. However, our pollutant data covers average concentrations of both NO_2 and PM10, for which impacts commonly have been found, and also includes counts of PM10 exceedence days²². None of these variables was related to LS.

EQ variation Our sample is unusual in that it deals with data from a single city, and it is possible that there is not enough EQ variation within the city boundaries to drive detectable LS effects²³.

Quantifying quality The inadequacy of current green space data sources was noted in subsection 6.1.1.9. Although we try a number of different green space indicators, it may be that none sufficiently captures the quality and accessibility of green spaces.

Omitted variables EQ in London might be highly correlated with other spatial characteristics that we cannot or do not observe; for example, the quality of local schools. We have controlled for house prices, for the distance to central London and public transport facilities, and for crime. Arguably, we could have tried including a wide range of additional controls.

Existence vs exposure The resolution of our data and our GIS techniques both represent significant advances on those used in previous LS research. However, even the best indicators of EQ around an individual's home may not necessarily correspond with the individual's exposure to or use of it. In the case of green space, for example, a person might live 100 yards from a park but never spend time there.

Spatial sorting As noted in subsection 2.2.3, there may be spatial sorting by EQ sensitivity, so that areas of lowest EQ are inhabited by those who are least sensitive to it. This could cause us to underestimate the impacts of EQ, perhaps to the point of not detecting them.

²²The LAEI maps include data on the number of days on which PM10 levels exceeded the EU-mandated limit of $50\mu\text{g}/\text{m}^2$. For our respondents' home locations this measure has a 0.99 correlation with the annual average figure, and is not significant when used in an alternative regression specification.

²³MacKerron & Mourato's results might indicate otherwise for air pollution; on the other hand, this is only one study, its sample is unrepresentative, and its findings are not unassailably robust (the coefficient on air pollution only just exceeds the 5% threshold).

Habituation It is known that individuals adapt to differing degrees to different kinds of circumstances. For example, as discussed in [subsubsection 2.5.1.2](#), individuals adapt to income levels to a very high degree. Approximately 80% of our sample have lived in the same house for at least two years, and 40% have lived there for at least ten. It is therefore possible that individuals in our sample have become substantially habituated to EQ in the vicinity of their homes, so that these no longer have much impact on LS²⁴.

No association Finally, we should consider the possibility that our London results tell us simply that LS is not significantly related to EQ there. LS is a broad, temporally non-specific, primarily cognitive indicator. It presumably reflects an individual's evaluation of his or her past, present, and possible futures, in relation to his or her hopes and expectations. Perhaps we should not expect such a quantity to be significantly related to EQ characteristics. Of course, this explanation would contradict a reasonable volume of previous research, and our own findings for the UK. To accept it, we would need to discount the results of those other studies (ascribing them, perhaps, to omitted variables and/or to coincidence plus publication bias). On balance, this would seem rather premature.

7.3.3 Sensitivity to choice of wellbeing indicators

Our two survey data sets include differing alternative indicators of wellbeing.

For London, our models having as dependent variables a multi-item life satisfaction scale and either of two more general wellbeing scales replicate our results using a single-item life satisfaction measure: no EQ parameter has a significant coefficient. In this limited sense our London results are robust to the use of different wellbeing indicators. Unfortunately this adds little of interest to our understanding of relations between SWB and EQ.

For the UK, we instead examine three shorter-run, affective SWB indicators: the PANAS (both positive and negative affect) and the emotional wellbeing sub-scale of the SF-36. Interestingly, our models using these as dependent variables have entirely different results to the LS models: no variable with a significant coefficient in the LS model has a significant coefficient in any affective SWB model, and vice versa. Our conclusions regarding EQ effects on SWB thus seem to exhibit a very high degree of sensitivity to the wellbeing indicator examined.

EQ and affect Models using the emotional wellbeing scale and the PANAS negative affect scale both suggest a positive relationship between local farmland and wellbeing. This might result from the benefits of green space outlined in [chapter 3](#). It could arguably also reflect other, unobserved characteristics of agricultural communities.

Our results are also quite different as between the positive and negative PANAS affect scales, with EQ links confined exclusively to the negative scale. Predicted negative affect scores are reduced with greater local farmland and suburban/developed rural land cover, and with closer proximity to rivers. Though by no means proof of such a hypothesis, this might suggest greater EQ impacts at the lower end of SWB (such as reducing depression) than at the higher end.

Comparison with previous findings Investigating health conditions, [Powdthavee & van den Berg \(2011\)](#) also find that estimates of SWB impacts (and associated monetary values) can vary substantially according to the SWB indicator selected. Our findings cast further doubt on the ability of SWB measures to be used uncritically in valuation work as a proxy for PS-style utility.

Studies on the EQ indicators used here have not been undertaken previously in the happiness economics literature but, as noted above, some epidemiological papers have found similar impacts of green spaces on psychological ill health. In the Netherlands [Maas et al. \(2009\)](#) find that more green space in a 1km or 3km radius of individuals' homes predicts fewer symptoms of anxiety and depression logged in medical records, and [de Vries et al. \(2003\)](#) report similar findings in relation to General Health Questionnaire (GHQ) scores, such that more green space predicts lower levels of psychological morbidity. These findings are also broadly consistent with the psychological theory and experimental evidence linking exposure to green space with improved mental health as summarised in [chapter 3](#).

²⁴Regarding MacKerron & Mourato's results, their convenience sample included a large number of students, who are more likely to be new to the city and hence less likely to have habituated fully to EQ.

7.3.4 Causation

Although we have tried to control for as many spatial and individual characteristics as is feasible, there might be variables missing from our models that are correlated with both happiness and EQ. These might be spatial characteristics (e.g. if school quality is correlated with air quality) or individual characteristics (e.g. if people with lower capital choose to live closer to green spaces). If such variables exist, then our estimated effects could be biased either up or down. There might also be an element of reverse causality. While EQ clearly does not vary in response to individuals' SWB levels, happier people might conceivably choose to live in locations with higher (or lower) EQ.

Therefore, in common with almost all previous research into this topic in happiness economics (excepting Luechinger, 2009), we cannot offer proof that the relationships we describe are causal ones. This is an important limitation of studies of this kind. It arises because of the difficulty of finding natural experiments: sources of exogenous (random) variation in individuals' spatial locations. In everyday life — the context that is of primary interest — people almost invariably choose where to be.

7.3.5 Summary

In summary, despite a number of methodological advances relative to previous research, our findings in this chapter are, at best, mixed. We find some positive relationships between SWB and green and blue spaces UK-wide, but these are not hugely robust. Meanwhile, in London we simply find no evidence of links between EQ and SWB.

In interpreting these results we have discussed some limitations of the approach taken here — and in most previous research — which uses cross-sectional survey data to relate an individual's usual location(s) to a single global evaluation of SWB. These limitations include issues of omitted spatial variables, the potential for habituation to and spatial sorting by EQ levels, and the difficulty of assessing real exposures to EQ. They may also include limitations of sample size, especially given the range of other influences on SWB reports, including potentially large time-invariant effects such as personality.

The following chapter reports results from our research using a novel spatial experience sampling approach, which ameliorates many of these limitations.

Chapter 8

Momentary happiness and the immediate environment

This chapter describes and analyses the large panel data set collected using the spatial experience sampling methodology detailed in [chapter 5](#), and augmented with objective spatial data using GIS as described in [chapter 6](#). We use this data to test the hypothesis that individuals' momentary feelings of happiness are positively related to EQ levels in their immediate surroundings. As indicators of EQ, we focus on land cover characteristics, while controlling for daylight and weather conditions. We control also for per-individual fixed effects and a large set of contextual indicators, including companionship and activity.

As noted previously, we believe both this hypothesis and this method to be novel within (and, in part, beyond) the happiness economics literature. As discussed in [subsection 2.2.2](#), the simple availability of any panel data has been a rarity in this area.

Section [8.1](#) describes our criteria for including and excluding data in our analyses. Section [8.2](#) characterises the data that is included, at both participant and response level. Section [8.3](#) reports on the models we estimate to quantify the relationship between happiness and immediate environment, and [section 8.4](#) discusses our findings.

All descriptions and analyses reported in this chapter are based on a snapshot of our ESM data covering the period of approximately six months from the app's launch to 14 February 2011.

8.1 Response validity

We describe as 'valid' the subset of response data which we both can include and judge should be included in our analyses. In subsequent sections the reported figures apply to these valid responses only.

We exclude duplicate response submissions¹ and responses from the researcher. We exclude incomplete responses, and those without GPS location data². We exclude responses from outside the UK, which are identified by the non-availability of LCM data. As a simple quality criterion, we exclude responses where more than twelve simultaneous activities have been ticked.

The cumulative effect on sample size of these criteria, and of those discussed next, is shown in [Table 8.1](#).

8.1.1 Response delay

To ensure a fully random sample of experiences, we would ideally like all participants to respond instantaneously to all signals. Since this is not realistic, varying judgments have been

¹Duplicate submissions occur where data transmission is interrupted after the data is received by the server, but before the server's acknowledgement of receipt is received by the app, so that the app re-sends at the next opportunity.

²More sophisticated options for the treatment of missing data, such as multiple imputation, are beyond the scope of this study.

Table 8.1: Response data inclusion criteria with cumulative effect on sample size

Criteria (cumulative)	# of responses	% of all responses
Response is not a duplicate submission or by the researcher (“all responses”)	1,964,326	100
and response is complete	1,953,212	99.43
and no more than 12 activities were ticked	1,952,788	99.41
and there was a signal outstanding	1,837,420	93.54
and the delay between signalling and response was less than 1 hour	1,347,193	68.58
and the response was completed within 5 minutes	1,332,806	67.85
and GPS location data were reported and within the UK	1,144,567	58.27
and location was not outdoors <i>or</i> GPS location accuracy was within 250m	1,139,905	58.03
and complete weather data is available for within 3 hours of response time (“valid responses”)	1,138,481	57.96

made in previous research regarding the maximum acceptable response delay, as discussed in [subsubsection 5.3.3.1](#). The exclusion of a response and the inclusion of a delayed response may both compromise the randomness of the sample, so the judgment made represents a trade-off between these two evils.

The delay between signal and response in our data, for all signals which ultimately received a response, is illustrated as a cumulative probability plot in [Figure 8.1](#). We choose to exclude responses where the delay is greater than 60 minutes (this point is marked on the plot by a vertical line).

This is a relatively long allowable delay in relation to what is usual in the EMA literature. [Stone & Shiffman \(2002, p. 239\)](#), for example, “would be uncomfortable with delays of 30 min or more”. As seen in [Table 8.1](#), however, it still results in a very substantial reduction in sample size.

8.1.2 Location accuracy and weather data

Again in an ideal world, we would like to know the geographical coordinates of each outdoor response with absolute precision, and we would like to know the weather conditions at that location at the precise moment of responding. Again, of course, we must in practice make a trade-off between accuracy and exclusion rate.

Outdoor reported GPS accuracy in our data is represented in [Figure 8.2](#). We choose to exclude outdoor responses with a reported accuracy worse than $\pm 250\text{m}$ (this threshold is again marked on the plot). As seen in the plot and in [Table 8.1](#), this has a fairly modest effect on sample size.

Distance to the nearest weather station, and the time difference of the closest weather observation at that station, are shown in [Figures 8.3](#) and [8.4](#). We accept the nearest weather station location in all cases — the distance is always less than 60km — and exclude responses only in the very rare case that complete weather data was not reported by that station within 3 hours (before or after) the response.

8.1.3 Robustness

We test the robustness of our findings to more stringent choices on response delay and location accuracy by re-running our main analysis with a maximum delay of 20 minutes and reported accuracy of 100m or better.

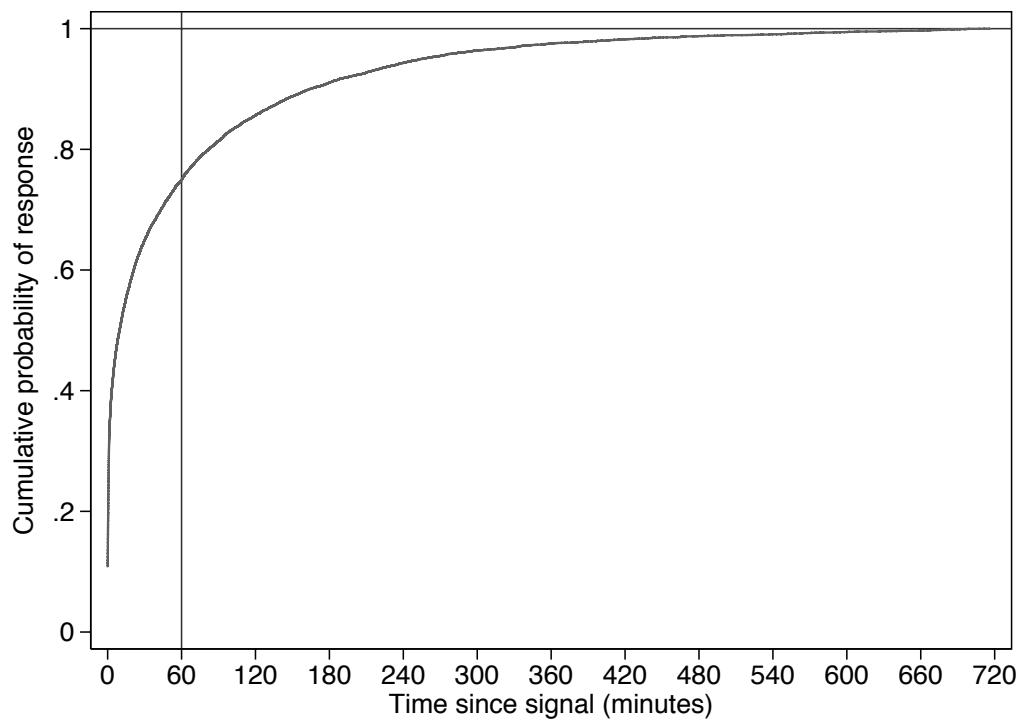


Figure 8.1: Response time — all responses

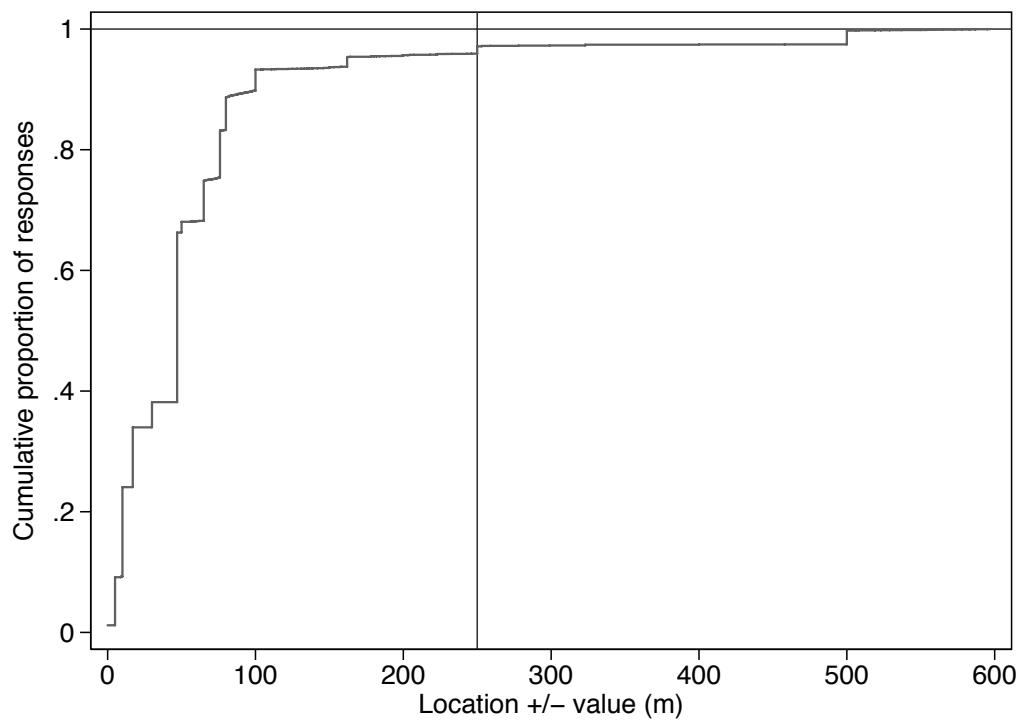


Figure 8.2: GPS reported location accuracy — all outdoor responses

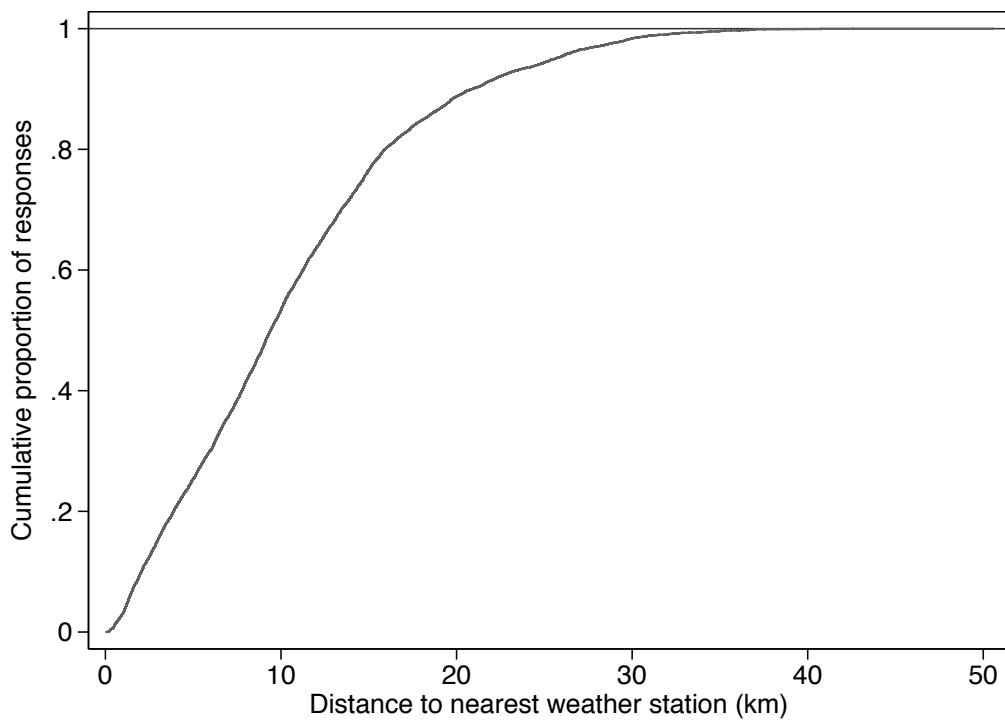


Figure 8.3: Distance to nearest weather station — all outdoor responses in UK

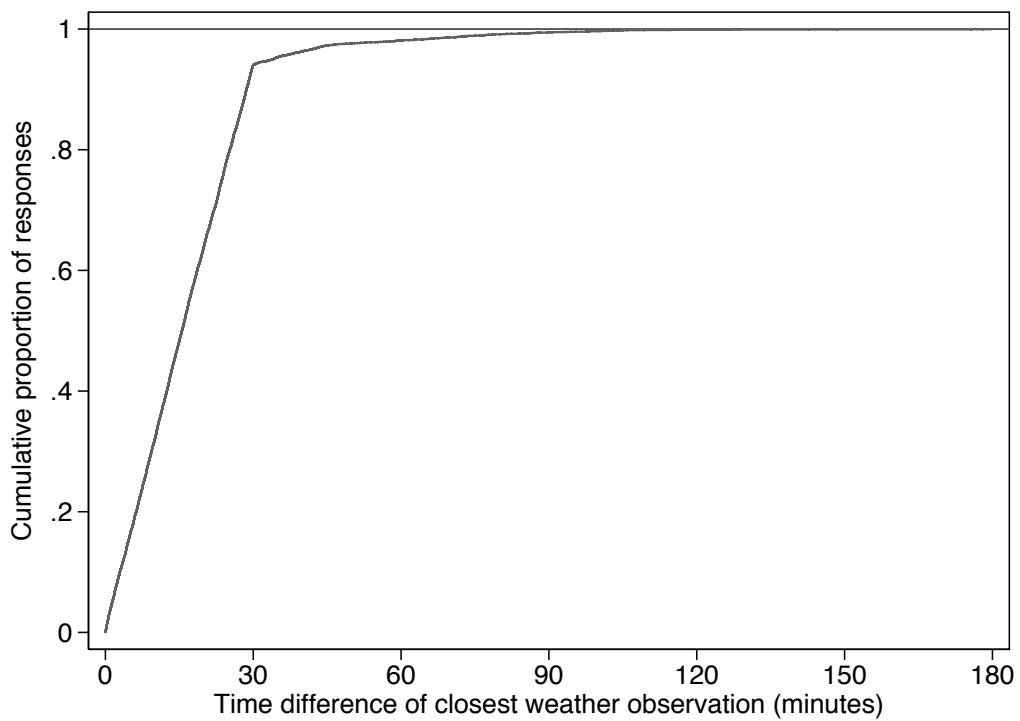


Figure 8.4: Time difference of closest weather observation — all outdoor responses in UK

Table 8.2: Top 25 signalling periods, considering only the most recent setting for each participant (these account for 77% of participants). Default is indicated in **boldface**.

Signalling period	# of participants	% of participants	Signalling period	# of participants	% of participants
08:00 – 22:00	9,017	41.09	07:00 – 23:00	189	0.86
09:00 – 22:00	1,427	6.50	08:00 – 00:00	186	0.85
10:00 – 22:00	937	4.27	09:00 – 20:00	184	0.84
08:00 – 21:00	702	3.20	09:30 – 22:00	174	0.79
08:00 – 23:00	618	2.82	10:00 – 20:00	153	0.70
09:00 – 21:00	588	2.68	08:00 – 22:30	143	0.65
07:00 – 22:00	412	1.88	07:30 – 22:00	141	0.64
09:00 – 23:00	342	1.56	12:00 – 22:00	126	0.57
08:00 – 20:00	261	1.19	10:00 – 00:00	123	0.56
10:00 – 21:00	251	1.14	08:00 – 21:30	120	0.55
10:00 – 23:00	232	1.06	07:00 – 21:00	114	0.52
11:00 – 22:00	231	1.05	09:00 – 00:00	109	0.50
08:30 – 22:00	215	0.98			

8.2 Descriptive results

8.2.1 Participant-level data

Data at participant level is reported only for participants contributing at least one valid response, of whom there are 21,947.

8.2.1.1 Participation rate

The opportunistic recruitment strategy used in this research does not enable us to calculate the overall participation rate — i.e. the number of individuals who took part as a proportion of those that had the opportunity to do so (which we might define rather broadly as all iPhone owners who encountered the app in the App Store, heard about the study on the radio or via Twitter, and so on). We can, however, investigate the attrition rate between downloading the app, registering to take part, and responding to signals.

Worldwide Globally, up to the end of 13 February 2011, the app had been downloaded 43,295 times (according to figures supplied by Apple), and 35,057 registrations had been received: approximately 81% of individuals who downloaded the app completed the registration process. Up to the same moment, one or more signalled responses (though not in all cases valid responses) had been received from 29,099 registered apps: hence approximately 83% of registering users — or 67% of downloading users — went on to respond to at least one signal.

UK There were 30,053 downloads from the UK App Store up to the end of 13 February. Registrations are not geo-located, but we can tell that 73% of those who downloaded the app from the UK App Store (21,947 participants) completed registration and went on to contribute one or more valid responses.

Table 8.3: Signals per day, considering only the most recent setting for each participant. Default is indicated in **boldface**.

Signals per day	# of participants	% of participants
2	10,475	47.73
3	3,053	13.91
1	1,942	8.85
5	1,704	7.76
4	927	4.22
0 (stopped participating)	3,846	17.52

8.2.1.2 Settings

The most recent signalling settings chosen by participants are shown in Tables 8.2 and 8.3. In both cases the default setting is by a large margin the most popular³.

Some participants have set signalling periods which seem unlikely to span the full waking day — for example, approximately 1% choose to be signalled 8am – 8pm. Arguably, we could have more effectively communicated the importance of sampling from across the day; however, as previously stated, our priority was to keep the burden on participants as low as possible.

8.2.1.3 Duration of participation

The number of responses per participant ranges from 1 to 737 (mean 51.9). The distribution of response counts is shown in Figure 8.5. 14% of participants were still actively responding when the data set was extracted, so this parameter is not the same as participants' final response count.

8.2.1.4 Demographics and sample representativeness

Our reliance on participants with iPhones clearly restricts the sample's demographic profile. Participants are relatively wealthy: median household income is approximately GBP £48,000, which is almost twice the UK median (House of Commons, 2006). Full income figures are given in Table 8.4.

Participants are also relatively young: 66% are aged under 35, and 95% under 50, compared to 29% and 56% respectively in the UK adult population (Office for National Statistics, 2010). The complete year-of-birth profile is illustrated in Figure 8.6 (which excludes one participant who claims to have been born in 1900, and includes approximately 600 who appear, in contradiction of the consent form agreement, to be aged under 18).

78% of participants are in employment and 13% are in full-time education. These groups are over-represented relative to the UK adult population, in which the proportions are respectively 57% and 4%, primarily at the expense of retired people, who constitute 0.5% of participants but 22% of the population (National Centre for Social Research, 2009). Participants' sex ratio is nearly balanced, at 56% male, compared to 49% in the UK adult population (Office for National Statistics, 2010). Further demographic characteristics are reported in Table 8.5.

8.2.1.5 Life satisfaction and health

Responses to the 1 – 10 overall life satisfaction item at registration follow the archetypal SWB distribution, skewed towards higher responses, with a modal answer of 7. The distribution of responses is shown in Figure 8.7.

Most participants rate their health as very good (42%) or good (33%). 13% suffer from a respiratory disease. Table 8.6 has the complete figures.

³This may be a demonstration of the phenomenon of 'sticky defaults' (Thaler & Sunstein, 2003), but we cannot rule out that the defaults happen also to be the options the largest number of participants would have chosen for themselves.

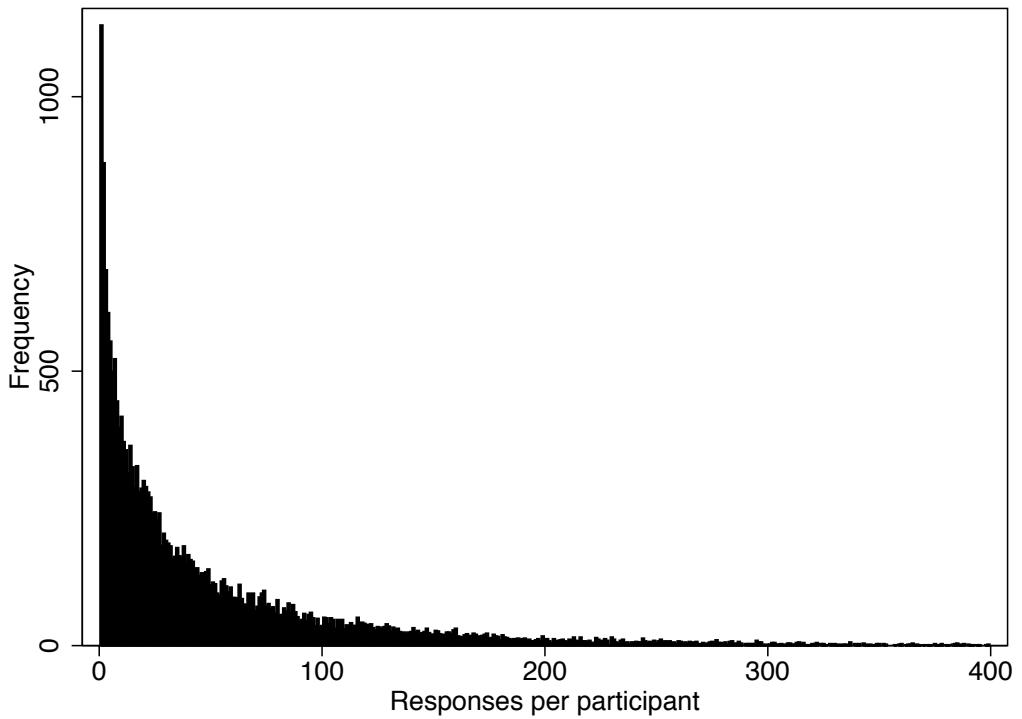


Figure 8.5: Distribution of the number of responses per participant (89 participants not shown here provided between 400 and 737 responses)

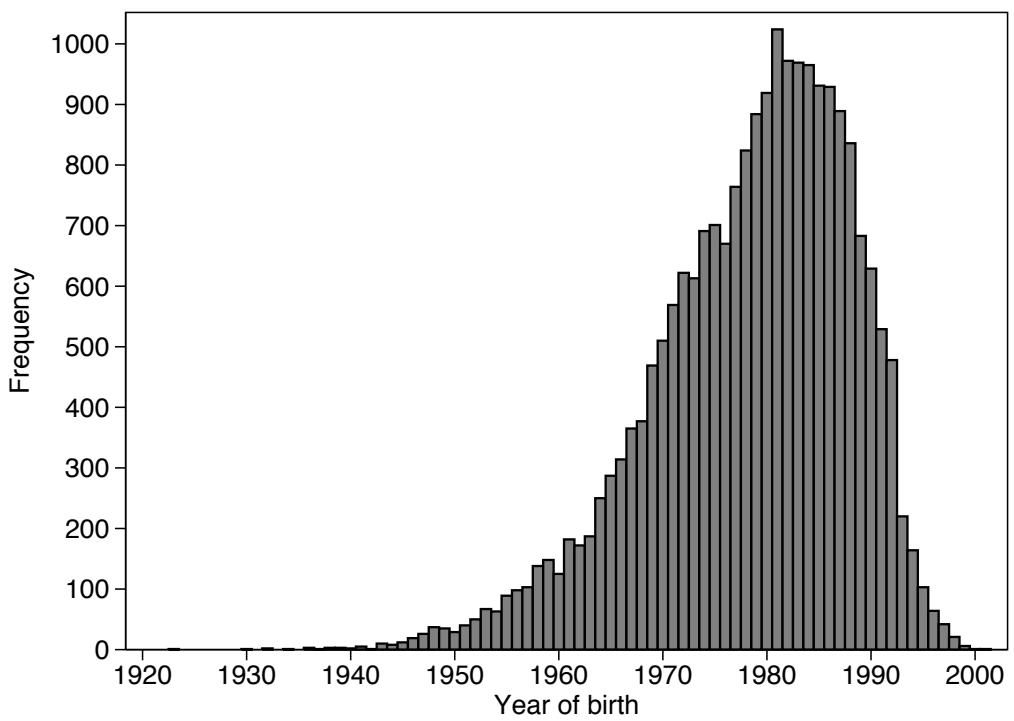


Figure 8.6: Distribution of year of birth (excluding a single response at 1900)

Table 8.4: Household income and income change

	# of participants	% of participants
<i>Gross annual household income</i>		
Under £8,000	1,017	4.63
£8,000 – £11,999	611	2.78
£12,000 – £15,999	898	4.09
£16,000 – £19,999	962	4.38
£20,000 – £23,999	1,233	5.62
£24,000 – £31,999	2,364	10.77
£32,000 – £39,999	2,526	11.51
£40,000 – £55,999	3,954	18.02
£56,000 – £71,999	2,853	13.00
£72,000 – £95,999	2,039	9.29
£96,000 or more	2,217	10.10
Not stated	1,273	5.80
<i>Change over past 3 years</i>		
– £16,000 or more	1,243	5.66
– £15,999 – – £8,000	737	3.36
– £7,999 – – £4,000	599	2.73
– £3,999 – – £2,000	350	1.59
– £1,999 – – £1,000	206	0.94
– £999 or less	117	0.53
No change	5,778	26.33
+ £999 or less	547	2.49
+ £1,000 – + £1,999	1,054	4.80
+ £2,000 – + £3,999	1,690	7.70
+ £4,000 – + £7,999	2,310	10.53
+ £8,000 – + £15,999	2,197	10.01
+ £16,000 or more	3,244	14.78
Not stated	1,875	8.54

Table 8.5: Demographic characteristics, ESM study

	<i># of participants</i>	<i>% of participants</i>
<i>Gender</i>		
Female	9,740	44.38
Male	12,207	55.62
<i>Marital status</i>		
Never married	13,691	62.38
Married and living with spouse	6,651	30.30
Divorced	978	4.46
Separated	560	2.55
Widowed	67	0.31
<i>Relationship status</i>		
Currently in a relationship (including 'married and living with spouse')	15,850	72.22
<i>Work status</i>		
Employed or self-employed	17,208	78.41
In full-time education	2,801	12.76
Unemployed and seeking work	725	3.30
Looking after family or home	515	2.35
Long-term sick or disabled	220	1.00
Retired	114	0.52
Other	364	1.66
<i>Number of adults (age ≥ 16) in the household</i>		
1	3,971	18.09
2	12,166	55.43
3	3,201	14.59
4 or more	2,609	11.89
<i>Number of children (age < 16) in the household</i>		
0	15,205	69.28
1	3,195	14.56
2	2,634	12.00
3	699	3.18
4 or more	214	0.98

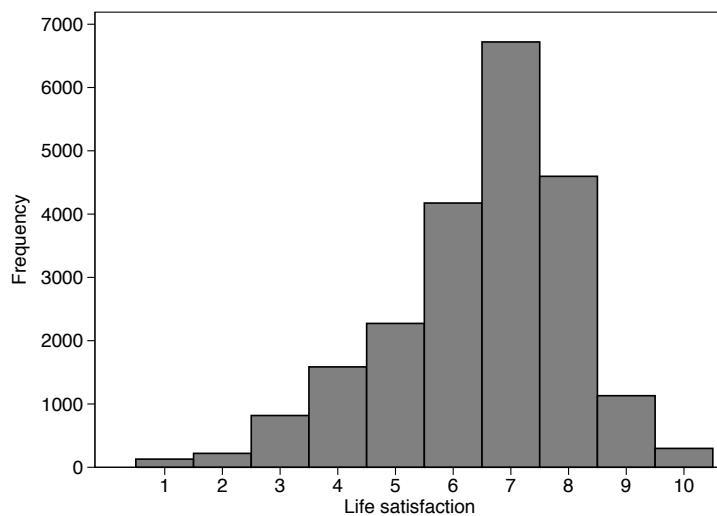


Figure 8.7: Distribution of life satisfaction self-report

Table 8.6: Health status

	# of participants	% of participants
<i>Health</i>		
Excellent	2,998	13.66
Very good	9,188	41.86
Good	7,238	32.98
Fair	2,140	9.75
Poor	383	1.75
<i>Asthma/respiratory disease</i>		
No	19,112	87.08
Yes	2,835	12.92

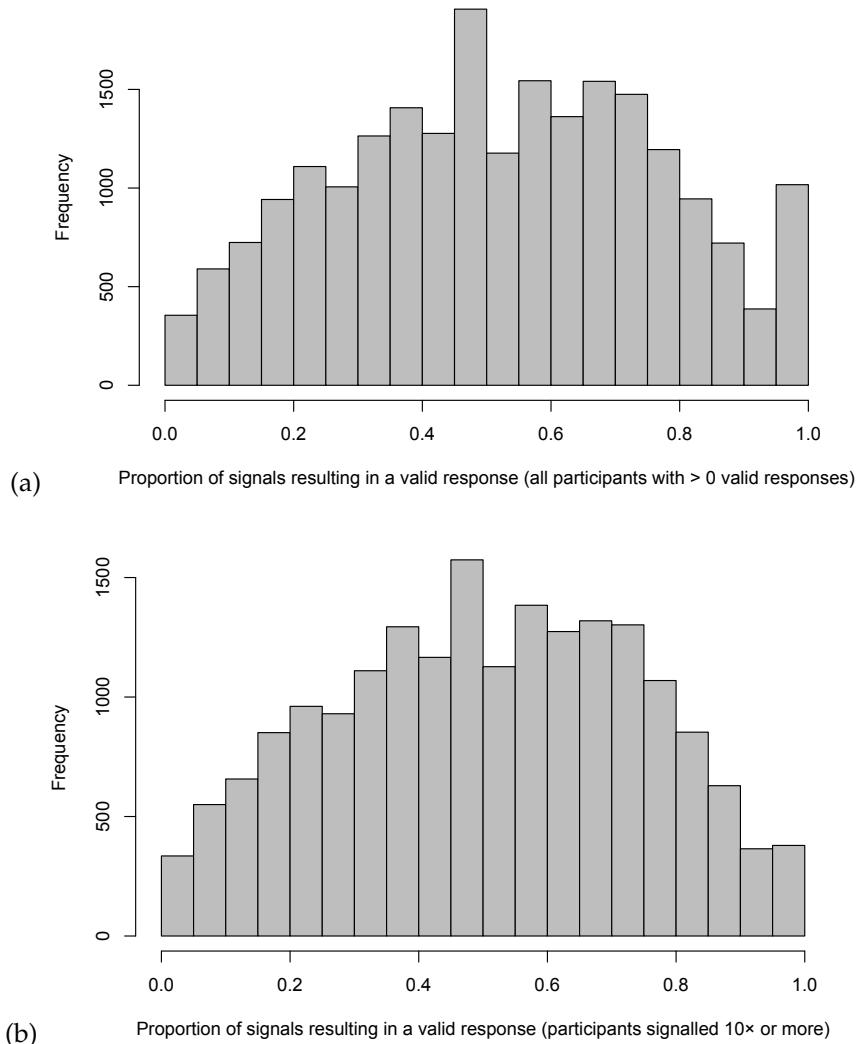


Figure 8.8: Distribution of the valid response rate by participant for (a) all participants contributing at least one valid response and (b) those who were, in addition, signalled at least ten times

8.2.2 Response-level data

8.2.2.1 Response rate

Overall, amongst participants who contributed at least one valid response (as defined in Table 8.1), the valid response rate to signals was 48.45%⁴. This response rate is low in relation to reports in the EMA literature. Although they admit the figure is “arbitrary”, Stone & Shiffman (2002, p. 240) propose a guideline lower bound of 80%, suggesting that rates below this raise questions over the representativeness of sampling.

On the other hand, our rate is not unprecedently low: Turk et al. (2007, p. 213), for example, report a response rate of 49.7% in an EMA study of fibromyalgia. Furthermore, we can be reasonably confident that these responses genuinely are valid — unlike studies using paper-based diaries, in which a large majority of seemingly valid responses have sometimes been discovered to have been fabricated long before or after the signalling time (Stone & Shiffman, 2002).

The distribution of the valid response rate across participants is shown in Figure 8.8. There is a broad and fairly symmetrical spread of rates.

⁴In calculating this fraction, we count in the denominator only beeps sent to participants we believe were still active at the time of sending. We consider a participant to have become inactive immediately after their last received response if one or more of these conditions were met when the data snapshot was taken: beeps per day was set to zero; the participant’s device had been reported inactive by Apple; or no responses had been received from the participant for at least 14 days.

Table 8.7: Frequencies of places

Place	# of valid responses	% of valid responses
At home	580,269	50.97
At work	279,242	24.53
Elsewhere	278,970	24.50
Indoors	972,398	85.41
Outdoors	85,102	7.48
In a vehicle	80,981	7.11

Table 8.8: Summary statistics for feelings responses

Feeling	Mean	Std. dev.
Happy	66.4	21.6
Relaxed	63.8	23.4
Awake	62.2	23.6

8.2.2.2 Location and place

Responses were sent from across the UK, but are concentrated around population centres, as seen in [Figure 8.9](#). We would not expect response densities, which reflect people’s locations during the day, to match residential densities exactly, but this broad comparability seems intuitive.

Just over half of all responses are completed at home, with the remainder split approximately equally between work and elsewhere. 85% of responses are completed indoors, and the rest are split approximately equally between outdoor and in-vehicle locations. [Table 8.7](#) shows the precise figures. There is a clear seasonal effect on time spent outdoors: in August a little over 10% of responses were out of doors, while for December the figure was just under 5%.

8.2.2.3 Feelings

Means and standard deviations of the Happy, Relaxed and Awake item responses are presented in [Table 8.8](#), and their distributions are charted in [Figure 8.10](#). The three distributions are very similar, and all show the typical peak at approximately 70% of the way to the scale’s top.

Each distribution also shows two artefacts of the response process: large spikes at the absolute extremes of the distribution, where the response slider is moved to its limit, and small troughs on either side of the midpoint, where the slider is most commonly either left in its initial position or moved a minimum distance to the left or right.

The three feelings items show substantial correlation, with coefficients of 0.71 for Happy – Relaxed, 0.41 for Happy – Awake, and 0.31 for Relaxed – Awake. In the rest of this chapter, we consider only the Happy response.

8.2.2.4 Activities

Participants most often report that they are working or studying (25% of occasions), watching TV or film (19%), and talking, chatting or socialising (15%). [Table 8.9](#) gives details of all activities.

UKTUS comparator To help understand the sampling limitations in this study — regarding both participant characteristics and the limits on when participants can and will respond to an ESM assessment signal, as discussed in [subsection 5.3.3](#) — we compare our reported activities with those recorded for a random population sample in a diary-based study. We use UK Time

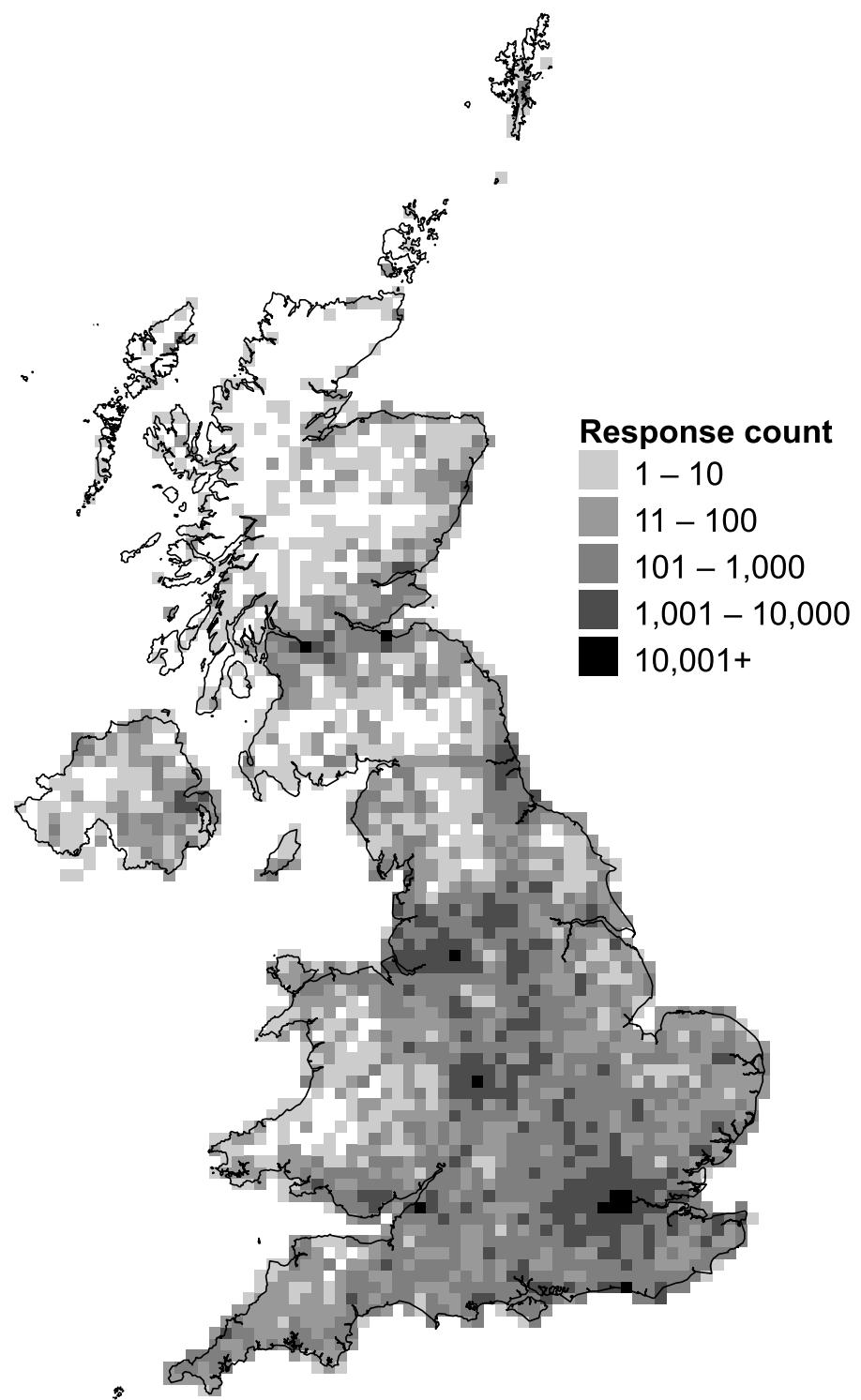


Figure 8.9: Map of response counts per 10km cell, shaded logarithmically, against the UK coastline

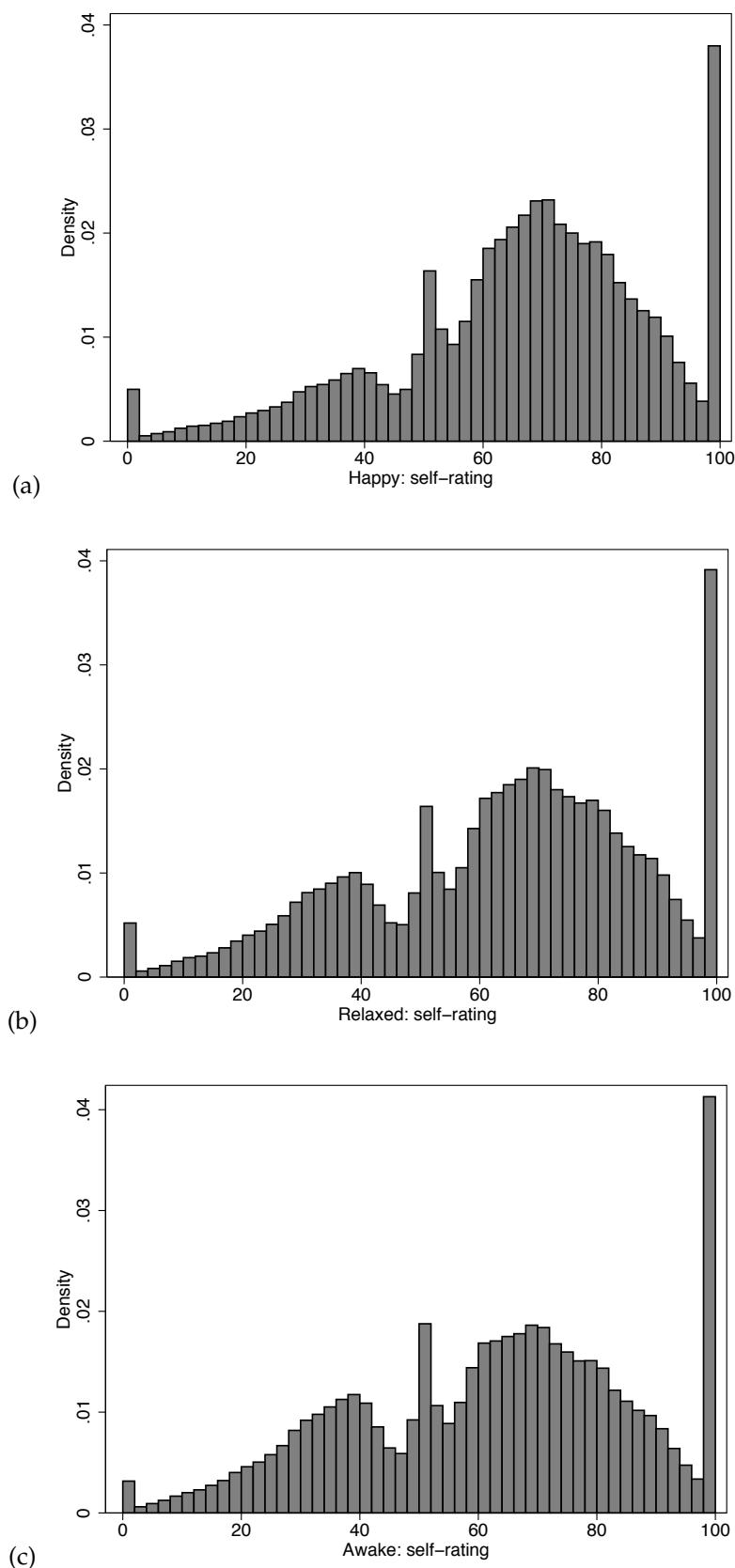


Figure 8.10: Distributions of feelings responses

Table 8.9: Frequencies of activities (not mutually exclusive). Starred activities were available only from app version 1.0.2.

<i>Activities</i>	# of valid responses	% of valid responses	<i>Activities</i>	# of valid responses	% of valid responses
Working, studying	285,268	25.06	Pet care, playing with pets	21,127	1.86
Watching TV, film	220,374	19.36	Sick in bed	19,199	1.69
Talking, chatting, socialising	169,852	14.92	Smoking	18,444	1.62
Sleeping, resting, relaxing	119,431	10.49	Listening to speech/podcast	16,872	1.48
Eating, snacking	109,251	9.60	Walking, hiking	13,847	1.22
Travelling, commuting	96,429	8.47	Sports, running, exercise	11,653	1.02
Listening to music	72,371	6.36	Hobbies, arts, crafts	10,457	0.92
Housework, chores, DIY	55,737	4.90	Match, sporting event	5,954	0.52
Drinking alcohol	55,444	4.87	* Intimacy, making love	5,484	0.48
Childcare, playing with children	51,091	4.49	Care or help for adults	5,325	0.47
* Drinking tea/coffee	49,917	4.38	Singing, performing	4,831	0.42
Cooking, preparing food	48,530	4.26	Other games, puzzles	4,436	0.39
* Browsing the Internet	45,676	4.01	Theatre, dance, concert	3,357	0.29
* Texting, email, social media	43,408	3.81	Meditating, religious activities	3,120	0.27
Computer games, iPhone games	42,432	3.73	Gardening, allotment	2,305	0.20
Admin, finances, organising	40,429	3.55	Exhibition, museum, library	2,201	0.19
Washing, dressing, grooming	38,894	3.42	Gambling, betting	955	0.08
Shopping, errands	36,048	3.17	* Birdwatching, nature watching	695	0.06
Reading	34,010	2.99	Hunting, fishing	293	0.03
In a meeting, seminar, class	29,892	2.63	Something else (app version < 1.0.2)	31,171	2.74
Waiting, queueing	24,375	2.14	Something else (app version ≥ 1.0.2)	30,682	2.69

Use Survey 2000 (UKTUS) data ([Office for National Statistics, 2005a](#)) to estimate approximate figures for comparison.

These UKTUS data list the average number of minutes in each 24-hour (1440-minute) period that participants spend in different activities. Because Mappiness only signals participants during waking hours, we subtract the time UKTUS respondents report they spend sleeping from the day length, and calculate the percentage of daily waking time (933 minutes) spent by UKTUS respondents in each activity.

UKTUS responses categorise activities according to a detailed, three-level classification, reproduced in [section E.1](#) on page 415 of Appendix E. We do our best to aggregate these categories to recreate the Mappiness activity types, but this is not possible at all for some activities, and in other cases results in a clearly inexact match.

In addition, the UKTUS data concern only what is considered the 'main' activity undertaken at any moment, whereas Mappiness asks about all activities without prioritisation. All other things being equal, we would therefore expect the proportions of time spent in each activity in the Mappiness data to be greater than in their UKTUS comparator, especially for potentially subsidiary or background activities.

The available comparisons are shown in [Table 8.10](#). In general, the figures appear encouragingly similar. Figures differing by more than a factor of two are highlighted in the table, and discussed below. In general, such differences appear to have plausible (though not provable) explanations in terms of the activity definitions and/or disparities in demographic profiles. Experience sampling issues might also contribute, however.

Talking, chatting, socialising This activity is substantially more prevalent in the Mappiness data set (15% vs 6%). This may be the result of our inclusion of the very general activity 'talking', which has no direct equivalent in the UKTUS classification, and/or the fact that socialising might often be considered secondary to a more specific activity, and thus not be captured as the UKTUS 'main' activity.

Computer games, iPhone games This activity appears over ten times more prevalent amongst our participants than in the UKTUS sample. This might reflect: the increasing reach of technology over the ten years separating the studies; gaming occurring as a secondary activity, such as while travelling; and, of course, the fact that every single one of our participants has access to a gaming device.

Sick in bed Again, this activity appears over ten times more common amongst Mappiness users. Given the young and wealthy demographic profile of Mappiness participants, this initially appears surprising. However, the UKTUS states clearly that this category is only "for sick, elderly or disabled in bed, *when no other activity is specified*" ([Office for National Statistics, 2003b](#), p. 143, emphasis ours). Therefore respondents who were also reading, eating, or watching TV, for example, would be included in our classification but not in the UKTUS one⁵.

Walking, hiking This activity is more common in our data (1.2% vs 0.4%). However, our category covers all walking, while the UKTUS data excludes 'trips with a special purpose (e.g. on foot to work)' ([Office for National Statistics, 2003b](#), p. 171).

Hobbies, arts, crafts Again, this activity is much more common in the Mappiness data (0.9% vs. 0.1%). The UKTUS category does not include arts and crafts, however, and the discrepancy could also be of demographic origin.

Match, sporting event The disparity here (0.5% in Mappiness vs 0.1% in UKTUS) might result from Mappiness participants including televised sport in their reports — this is not counted by UKTUS ([Office for National Statistics, 2003b](#), p. 169).

Theatre, dance, concert Again, this activity is more prevalent amongst Mappiness users (0.3% vs 0.1%). This might relate to demographic factors.

⁵It also seems possible that individuals suffering from long-term illness could be differentially attracted to participating in a voluntary wellbeing study such as Mappiness.

Table 8.10: Activity comparisons with UK Time Use Survey 2000 ‘main’ activities. Differences greater than a factor of two are highlighted in **boldface**.

<i>Mappiness activities</i>	<i>Mappiness % of occasions</i>	<i>UKTUS % of waking minutes</i>	<i>UKTUS codes (see section E.1)</i>
Working, studying	25.06	20.15	10, 111, 121, 13, 2
Watching TV, film	19.36	15.97	521, 821, 822
Talking, chatting, socialising	14.92	6.11	51*
Eating, snacking	9.60	9.32	02
Travelling, commuting	8.47	9.11	9A
Housework, chores, DIY & Admin, finances, organising	8.45	8.36	30, 313, 32, 33, 35, 37
Childcare, playing with children	4.49	2.79	38, 427, 938
Cooking, preparing food	4.26	4.61	310 – 312, 314, 319
Computer games, iPhone games	3.73	0.32	733
Washing, dressing, grooming	3.42	5.04	03
Shopping, errands	3.17	3.32	36
Reading	2.99	3.00	81
Pet care, playing with pets	1.86	1.07	342 – 344
Sick in bed	1.69	0.11	012
Walking, hiking	1.22	0.43	611**
Sports, running, exercise	1.02	1.18	60, 610, 612 – 617, 619, 63
Hobbies, arts, crafts	0.92	0.11	720, 721, 729***
Match, sporting event	0.52	0.11	525
Care or help for adults	0.47	0.64	39, 420 – 426, 428, 429
Singing, performing	0.42	0.21	711, 712
Other games, puzzles	0.39	0.54	730 – 732, 739
Theatre, dance, concert	0.29	0.11	522****
Meditating, religious activities	0.27	0.43	432*****
Gardening, allotment	0.20	0.96	341
Exhibition, museum, library	0.19	0.11	523, 524
Gambling, betting	0.08	0.11	734
Hunting, fishing	0.03	0.11	621

* This ‘social life’ super-category is probably narrower than the Mappiness category.

** Excludes ‘trips with a special purpose’, such as commuting. *** Hobbies only.

**** Dance not included. ***** Religious activities only.

Table 8.11: Frequencies of companionship (not mutually exclusive, except for 'Alone')

Companionship	# of valid responses	% of valid responses
Alone or with strangers only	460,158	40.42
Spouse, partner, girl/boyfriend	277,073	24.34
Colleagues, classmates	204,697	17.98
Children	121,555	10.68
Friends	109,627	9.63
Other family members	96,814	8.50
Other people participant knows	18,624	1.64
Clients, customers	18,510	1.63

Gardening, allotment Unusually, this activity is substantially more common in the UKTUS data (1% vs 0.2%). This might be linked to the lack of older and retired people in our sample. There might also be experience sampling explanations, however: gardeners may not be possession of their iPhone; might not hear the signal above the noise of garden equipment; or may be unable to respond with dirty hands or while wearing gloves.

Hunting, fishing This activity is also more — and perhaps surprisingly — prevalent in the UKTUS data (1% vs 0.03%). Again, this may have demographic and/or experience sampling causes.

8.2.2.5 Companionship

Participants report being alone or only with strangers on 40% of valid response occasions. When not alone, they are most frequently with partners (24% of occasions) and/or colleagues (18%). Full companionship statistics are provided in [Table 8.11](#).

UKTUS comparator UKTUS respondents are not asked whom they are with when at work or studying, and do not always provide an answer to the question at other times. The data are therefore consistent with UKTUS respondents being alone or with people they do not know during between 21% and 47% of the waking day (calculations based on [Office for National Statistics, 2005b](#)), and our data fall well within these bounds. The other UKTUS companionship categories cannot be mapped to ours.

8.2.2.6 Device

Owing to the validity requirements that a signal be pending and a location be reported, a much larger proportion of the responses from GPS- and mobile Internet-equipped devices (the iPhone 3G, 3GS and 4, and some iPads) are valid. This difference is even greater outdoors: in this case non-GPS, non-cellular devices will rarely be capable of receiving a signal, or have any means of estimating location, and the iPhone 3G, 3GS and 4 account for all but 326 valid responses. Complete response counts by device are given in [Table E.1](#) in Appendix E.

8.2.2.7 Photos

In total, 7.14% of valid responses included a photo. The numbers are broken down by response location type in [Table 8.12](#). As discussed in [5.2.2.2](#), participants were by default prompted for a photo only when outdoors, which accounts for the much larger proportion of photos contributed in this context.

The photos are not used in any further analysis here. In future research we intend to use them to augment the available environmental data by using manual coding and/or computer vision techniques to identify characteristics of natural and/or built environments.

Table 8.12: Contributed photo counts by location

Location	# of photos	% by location
Indoors	15,249	1.57
Outdoors	64,317	75.58
In a vehicle	1,743	2.15

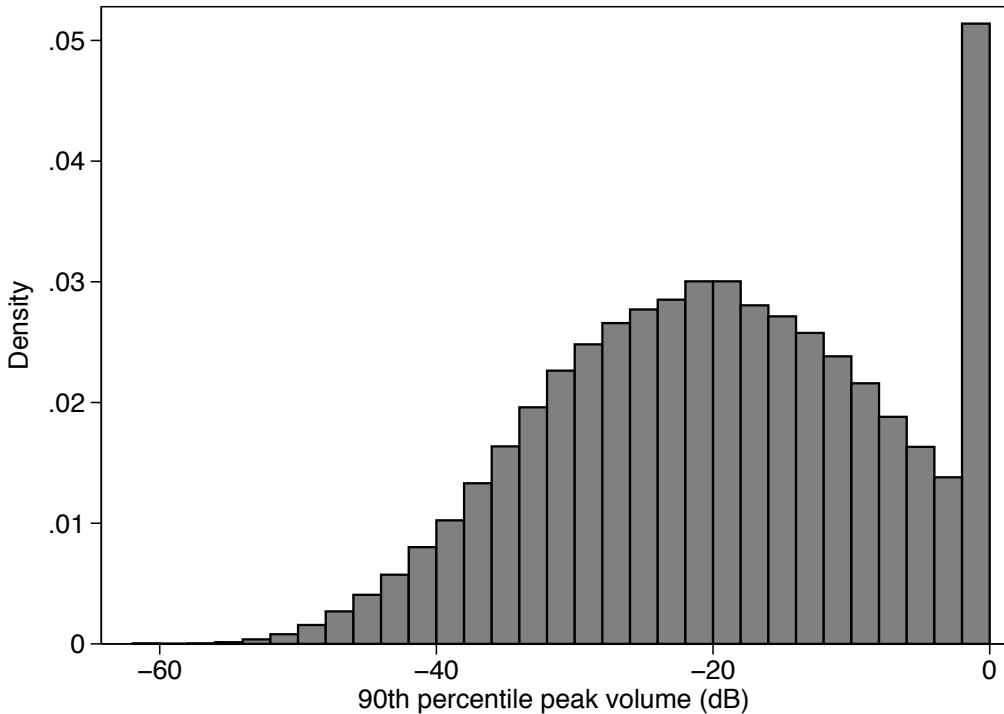


Figure 8.11: Distribution of 90th percentile peak volume measure. Detectable range: between -160 and 0 dB. Not shown: 192 responses between -160 and -70 dB.

8.2.2.8 Noise

Of valid responses, 96.5% included noise measurements (as noted in subsubsection 5.4.2.3, noise measurements are not made when participants are using their device to listen to audio). The distribution of the 90th percentile of the reported peak volume is illustrated in Figure 8.11. A simple OLS regression (not shown) demonstrates that noise measures vary significantly by activity and location type⁶, and also by reporting device.

For a number of reasons, these noise level measures are not considered further here. First, the iPhone's built-in microphone is directional and easy to occlude, and noise measures will therefore depend on the orientation and grip in which the device is held. Second, as suggested in subsubsection 5.4.2.3 and potentially confirmed by the simple regression reported above, differences in hardware and/or software between device models mean that measured levels are not universally comparable. Finally, since we have only a simple volume measure, we cannot directly establish anything about the nature of the noise detected — for example, we cannot distinguish between traffic, roadworks, a crowd or a concert. Dealing satisfactorily with these issues is beyond the scope of this thesis, though it may well be possible to make use of the noise data in future research.

⁶The quietest activity is 'Sleeping, resting, relaxing'; the loudest is 'Theatre, dance, concert'. Of location types, in-vehicle responses are the noisiest, with outdoor responses close behind.

Table 8.13: Frequencies of habitat types when participants are outdoors

<i>LCM NEA categories when outdoors</i>	# of valid responses	% of valid outdoor responses	% of valid responses
Continuous urban	43,072	50.61	3.78
Suburban/rural developed	22,119	25.99	1.94
Enclosed farmland	9,235	10.85	0.81
Semi-natural grasslands	3,910	4.59	0.34
Woodland	3,323	3.90	0.29
Inland bare ground	1,630	1.92	0.14
Marine and coastal margins	735	0.86	0.06
Freshwater, wetlands and flood plains	668	0.78	0.06
Mountains, moors and heathland	410	0.48	0.04

Table 8.14: Frequencies of countryside designations when participants are outdoors

<i>Designations when outdoors</i>	# of valid responses	% of valid outdoor responses	% of valid responses
National Parks	1,402	0.02	0.00
Areas of Outstanding Natural Beauty	2,462	0.03	0.00
National Nature Reserves	117	0.00	0.00

8.2.2.9 Spatial variables

We consider land cover, countryside designation status and weather conditions only as interactions with being outdoors. Although it is possible that these variables are also associated with happiness when participants are indoors or in a vehicle, the same direct link from environmental exposure to mood cannot be posited with any confidence in these cases. In addition, when participants are not outdoors their location is less accurately determined by GPS, making these spatial data less reliable.

Land cover According to LCM data (see [subsubsection 6.1.1.4](#)), a little over half of outdoor responses come from the continuous urban habitat type, and just over a quarter from the suburban/rural developed type. The seven non-urban types thus account for just under a quarter of outdoor responses between them. The least frequently observed habitat type outdoors (mountains, moors and heathland) accounts for less than 0.5% of outdoor responses, and less than 0.05% of all responses — confirming the value of having collected a very large data set. A full summary is given in [Table 8.13](#).

Designation status The numbers of responses from outdoor locations subject to the three designations discussed in [subsubsection 6.1.1.5](#) are given in [Table 8.14](#).

Weather conditions Frequencies of different weather conditions and daylight for outdoor responses are shown in [Table 8.15](#). In the absence of an *a priori* hypothesis regarding the functional form of a relationship between temperature and happiness, we create dummy variables corresponding to five temperature ranges. Similarly, we create dummies for four ranges of wind speed.

Table 8.15: Frequencies of daylight and weather conditions when participants are outdoors

<i>Weather conditions when outdoors</i>	# of valid responses	% of valid outdoor responses	% of valid responses
Daylight	69,015	81.10	6.06
Sunny (clear \times daylight)	10,321	12.13	0.91
Rainy	7,441	8.74	0.65
Foggy	1,236	1.45	0.11
Snowy	589	0.69	0.05
<i>Air temperature</i>			
< 0°C	2,193	2.58	0.19
0 – 7°C	13,130	15.43	1.15
8 – 15°C	32,961	38.73	2.90
16 – 23°C	36,636	43.05	3.22
$\geq 24^\circ\text{C}$	182	0.21	0.02
<i>Windspeed</i>			
0 – 4 km/h	12,064	14.18	1.06
5 – 14 km/h	34,378	40.40	3.02
15 – 24 km/h	28,746	33.78	2.52
≥ 25 km/h	9,914	11.65	0.87

8.3 Analysis

We believe the sample supporting this analysis — over 1,000,000 assessment responses, from more than 20,000 participants — to be the largest ever achieved by an ESM study.

8.3.1 Model building

As discussed in [subsubsection 6.2.2.1](#), we estimate fixed effects models from the ESM data. We run three models, each with reported happiness as the dependent variable (scaled 0 – 100).

The first model includes only spatial characteristics — whether the respondent is indoors, outdoors or in a vehicle, and land cover and weather when outdoors — as explanatory variables. The second model adds control variables from the ESM assessment survey — activity, companionship, and whether the respondent is at home, at work or elsewhere — to the specification. Finally, the third model also adds indicators of the day and time, and of the position of the response in the contributing participant’s response sequence.

The third model is presented below in [Table 8.16](#), while the first and second models are shown in [section E.3](#) of [Appendix E](#).

The largest EQ (land cover) impacts on predicted happiness are seen in the first model. The addition of companionship, activity and location type controls in the second model reduces the size of the land cover coefficients by approximately a factor of two⁷. This appears intuitive: for example, the occasions on which people visit a park or the countryside may well be associated with leisure activities, relaxation and good company. Therefore, if we do not control for these factors we are liable to overestimate the link with land cover alone. Differences between the second model and the third model are much less great, although the inclusion of additional controls in the third model does again very slightly reduce the land cover coefficients.

⁷The R² statistic also jumps from 0.6% in the first model to 13.1% in the second. The reason for the first model’s very low R², despite large and significant coefficients on the explanatory variables, is the low rate of responses received from outdoor, non-urban locations, which was noted in [subsubsection 8.2.2.9](#).

In the remainder of this chapter we focus exclusively on the the third model, incorporating the widest range of control variables. We refer to this as our main land cover model.

Table 8.16: Main land cover model

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Location</i>			
Indoors (base category)			
In a vehicle	-0.17	(0.14)	0.217
Outdoors	2.32	(0.45)	< 0.001
At home (base category)			
At work	-2.59	(0.12)	< 0.001
Elsewhere	1.73	(0.09)	< 0.001
<i>Land cover type when participant is outdoors</i>			
Continuous urban (base category)			
Marine and coastal margins	6.02	(0.68)	< 0.001
Mountains, moors and heathland	2.71	(0.87)	0.002
Woodland	2.12	(0.34)	< 0.001
Semi-natural grasslands	2.04	(0.35)	< 0.001
Enclosed farmland	2.03	(0.24)	< 0.001
Freshwater, wetlands and flood plains	1.80	(0.63)	0.004
Suburban/rural developed	0.88	(0.16)	< 0.001
Inland bare ground	0.37	(0.47)	0.435
<i>Daylight & weather when participant is outdoors</i>			
Daylight	-0.11	(0.17)	0.509
Snow	1.02	(0.72)	0.156
Sun	0.46	(0.18)	0.013
Fog	-1.35	(0.54)	0.012
Rain	-1.37	(0.22)	< 0.001
< 0 °C (base category)			
0 – < 8 °C	-0.51	(0.41)	0.220
8 – < 16 °C	0.29	(0.42)	0.484
16 – < 24 °C	0.99	(0.42)	0.019
24+ °C	5.13	(1.21)	< 0.001
0 – < 5 km/h windspeed (base category)			
5 – < 15 km/h windspeed	-0.20	(0.19)	0.285
15 – < 25 km/h windspeed	-0.52	(0.20)	0.009
25+ km/h windspeed	-0.94	(0.25)	< 0.001
<i>Activities</i>			
Intimacy, making love	12.90	(0.32)	< 0.001
Sports, running, exercise	6.51	(0.19)	< 0.001
Theatre, dance, concert	6.49	(0.31)	< 0.001
Singing, performing	5.87	(0.33)	< 0.001

continues ...

... continued

<i>Variable</i>	<i>Coeff.</i>	<i>Std. err.</i>	<i>Pr(coeff. = 0)</i>
Exhibition, museum, library	5.59	(0.36)	< 0.001
Hobbies, arts, crafts	5.29	(0.21)	< 0.001
Talking, chatting, socialising	4.46	(0.08)	< 0.001
Birdwatching, nature watching	4.32	(0.62)	< 0.001
Drinking alcohol	4.12	(0.11)	< 0.001
Meditating, religious activities	3.66	(0.47)	< 0.001
Listening to music	3.55	(0.10)	< 0.001
Gardening, allotment	3.55	(0.44)	< 0.001
Hunting, fishing	3.28	(1.36)	0.016
Pet care, playing with pets	3.18	(0.21)	< 0.001
Childcare, playing with children	3.00	(0.17)	< 0.001
Computer games, iPhone games	2.97	(0.12)	< 0.001
Walking, hiking	2.55	(0.18)	< 0.001
Other games, puzzles	2.35	(0.26)	< 0.001
Watching TV, film	2.29	(0.07)	< 0.001
Match, sporting event	2.29	(0.28)	< 0.001
Eating, snacking	2.22	(0.06)	< 0.001
Cooking, preparing food	2.15	(0.10)	< 0.001
Washing, dressing, grooming	2.01	(0.11)	< 0.001
Listening to speech/podcast	1.98	(0.15)	< 0.001
Gambling, betting	1.93	(0.71)	0.007
Reading	1.71	(0.11)	< 0.001
Drinking tea/coffee	1.40	(0.11)	< 0.001
Shopping, errands	0.97	(0.11)	< 0.001
Sleeping, resting, relaxing	0.96	(0.09)	< 0.001
Texting, email, social media	0.76	(0.13)	< 0.001
Browsing the Internet	0.75	(0.10)	< 0.001
Smoking	0.16	(0.20)	0.422
In a meeting, seminar, class	0.06	(0.17)	0.73
Housework, chores, DIY	-0.87	(0.10)	< 0.001
Something else (app version < 1.0.2)	-1.38	(0.16)	< 0.001
Admin, finances, organising	-1.72	(0.16)	< 0.001
Working, studying	-1.92	(0.10)	< 0.001
Travelling, commuting	-2.03	(0.12)	< 0.001
Something else (app version \geq 1.0.2)	-3.27	(0.19)	< 0.001
Care or help for adults	-3.96	(0.60)	< 0.001
Waiting, queueing	-4.11	(0.15)	< 0.001
Sick in bed	-19.65	(0.29)	< 0.001

Companionship

Spouse, partner, girl/boyfriend	4.51	(0.11)	< 0.001
<i>continues ...</i>			

... *continued*

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
Friends	4.38	(0.09)	< 0.001
Other family members	0.75	(0.10)	< 0.001
Clients, customers	0.43	(0.41)	0.290
Children	0.27	(0.15)	0.069
Colleagues, classmates	-0.29	(0.13)	0.025
Other people participant knows	-0.83	(0.19)	< 0.001
<i>Time of day, day of week dummies</i>			
Mon – Fri, midnight – < 3am	3.00	(0.44)	< 0.001
Mon – Fri, 3am – < 6am	-0.56	(1.16)	0.627
Mon – Fri, 6am – < 9am (base category)	—		
Mon – Fri, 9am – < noon	3.20	(0.12)	< 0.001
Mon – Fri, noon – < 3pm	3.57	(0.12)	< 0.001
Mon – Fri, 3pm – < 6pm	3.44	(0.12)	< 0.001
Mon – Fri, 6pm – < 9pm	2.80	(0.13)	< 0.001
Mon – Fri, 9pm – < midnight	3.15	(0.14)	< 0.001
Sat – Sun, midnight – < 3am	4.50	(0.67)	< 0.001
Sat – Sun, 3am – < 6am	2.26	(1.67)	0.178
Sat – Sun, 6am – < 9am	2.88	(0.21)	< 0.001
Sat – Sun, 9am – < noon	4.27	(0.14)	< 0.001
Sat – Sun, noon – < 3pm	4.30	(0.14)	< 0.001
Sat – Sun, 3pm – < 6pm	4.06	(0.14)	< 0.001
Sat – Sun, 6pm – < 9pm	4.11	(0.14)	< 0.001
Sat – Sun, 9pm – < midnight	4.02	(0.16)	< 0.001
<i>Participant's response number</i>			
Response #1	-5.74	(0.67)	< 0.001
Response #2 – #11	-3.56	(0.12)	< 0.001
Response #12 – #51	-0.94	(0.09)	< 0.001
Response #52+ (base category)	—		
Participant-level fixed effects			
Constant (mean fixed effect)	60.70	(0.14)	< 0.001
Observations			
Groups (participants)	21947		
R ² (within groups)	13.5%		

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Within sections, explanatory variables are ordered by descending coefficient, *except* where variables themselves are ordered.

8.3.2 Control variables

Coefficients on control variables in the main land cover model demonstrate relationships with reported happiness that are in all cases highly intuitive.

All effects are, of course, controlled for all others, so results are somewhat different than when considering each factor in isolation. For example, simple mean happiness on weekdays keeps rising to an evening peak, whereas in the model — after controlling for activity, companionship, and other factors — the happiest period is mid-afternoon.

8.3.2.1 Activity

Participants' happiest activity, by a large margin, is intimacy or lovemaking. Physical exercise, cultural activities (theatre, dance, concert, exhibition, museum, library) and creative and performative activities (singing, performing, hobbies, arts, crafts) also score very highly.

Participants are notably happy when engaged in various activities that may be common in natural environments, including gardening, hunting, fishing, hiking and birdwatching.

Participants are least happy when sick in bed, with a negative coefficient more than four times the size of the next greatest. Queuing, care-giving, and travelling are also associated with significantly reduced happiness, as is the commonest activity in the data set: working or studying.

Note that, since the activity dummy variables are not mutually exclusive, there is no base category in the model.

8.3.2.2 Companionship

The companionship dummies are not mutually exclusive, but the implicit base category (when all are zero) is 'Alone or with strangers only'.

The company of a partner or friend is strongly associated with greater happiness. Responses in the presence of other family members are slightly happier than those when the participant is alone.

Conversely, responses in the company of colleagues and other acquaintances are slightly less happy. Happiness when with children, clients or customers is not significantly different from happiness when alone.

8.3.2.3 Time

All else being equal, participants are significantly less happy during weekday early mornings (3am – 9am) and the very early hours of weekend days (3am – 6am) than at any other time. Since we include only signalled responses in our analyses, participants responding during these hours presumably expected to be awake. Such responses therefore appear more likely to be associated with the demands of employment (including shift working) than with being woken by a child, for example.

Participants are also happier at any time of day during the weekend than at the corresponding time during the week. *F* tests show this weekday/weekend difference to be significant at the 5% level for all periods except 3am – 6am⁸.

⁸It might also seem reasonable to hypothesise seasonal effects on happiness, which could include impacts of Seasonal Affective Disorder (SAD): "seasonal variation in mood has been documented thoroughly by both retrospective and prospective studies. In the general population, depressive symptoms peak in winter, and the most extreme form of this disposition, SAD, appears to be a relatively common disorder" (Magnusson, 2000, p. 176). In a separate regression specification, shown in Table E.3 in section E.4, we therefore added month dummy variables to the main land cover model. However, none of the coefficients on these month dummies were significantly different from zero, and none of the other coefficients in the model were meaningfully affected by the inclusion of the dummies.

8.3.2.4 Sequence

Reported happiness on average increases substantially during the course of an individual's participation. There could be a number of explanations for this.

Although the aim of the study is to observe natural levels of wellbeing, and not to influence those levels, regular prompts to report on wellbeing might well have some wellbeing effects. For example, it may be that taking part in the study leads to increased reflection on states of mind and awareness of the factors that affect them, enabling participants to act to improve their mood. We have received correspondence from participants providing anecdotal support for this explanation.

It may also be that participants initially respond to signals assiduously, irrespective of mood, but in later stages are more inclined to respond when feeling good⁹. We have received correspondence from participants supporting this explanation too.

8.3.3 Location and environment

Participants are happier at home than at work, and happier still when in neither location. Happiness levels when indoors or in a vehicle are not significantly different, but participants are happier than in either when they are outdoors.

8.3.3.1 Weather

Weather variables — considered only when participants are outdoors — have significant effects on predicted happiness.

Participants are happier when temperatures are higher. In particular, a large jump in happiness levels is associated with the highest temperature category, 24°C and above. This effect is of a similar magnitude to those of the happiest activities: approximately 5 points on the 0 – 100 happiness scale, or one quarter of a standard deviation.

Slightly greater happiness is also associated with sunshine. By contrast, high wind speeds, rain and fog are all linked to somewhat lower happiness levels. The coefficients on daylight and snow are not significant.

8.3.3.2 Land cover

We now turn to the regression results bearing directly on our research hypothesis.

When outdoors, every habitat type except inland bare ground is associated with significantly higher happiness levels than continuous urban.

Coastal locations are by some distance the happiest, with responses approximately 6 points higher than continuous urban environments on the 0 – 100 scale. Alternatively expressed, this is a difference of 0.28 standard deviations, or one of similar magnitude to, for instance, the difference between attending an exhibition and doing housework.

All other green or natural environment types — mountains, moors, heathlands, woodlands, grasslands, farmland, freshwater, wetlands and flood plains — are between 2.7 and 1.8 points happier than continuous urban environments. Suburban or rural developed environments are a little under one point happier.

8.3.3.3 Additivity

Accounting for the fact that participants are in any case happier outdoors than indoors, an additional 2.3 scale points (one tenth of a standard deviation) may be added to each land cover coefficient if we wish to compare happiness levels outdoors in these higher-EQ environments with levels indoors in a continuous urban environment.

⁹Unfortunately, the design of the Mappiness database schema makes this hypothesis particularly difficult to test.

Table 8.17: Landscape designation model

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Landscape designation when participant is outdoors</i>			
National Nature Reserve	5.00	(1.62)	0.0020
National Park	4.59	(0.58)	< 0.0001
Area of Outstanding Natural Beauty	2.39	(0.55)	< 0.0001
All other variables except land cover from main land cover model		Yes	
Observations	1138481		
Groups (participants)	21947		
R ² (within groups)	13.5%		

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Certain activities, such as gardening, birdwatching, hunting and fishing, may be mainly or exclusively carried on outdoors in green or blue spaces. And, of course, people may be more likely to venture into high-EQ outdoor environments in pleasant weather. Assuming, of course, that our model is correctly specified in its inclusion of most variables as independent effects, we may simply add coefficients together to compare predicted happiness in such scenarios.

Thus, for example, the predicted happiness of a person who is outdoors (+2.32), birdwatching (+4.32) with friends (+4.38), in heathland (+2.71), on a hot (+5.13) and sunny (+0.46) Sunday early afternoon (+4.30) is approximately 26 scale points (1.2 standard deviations) higher than that of someone who is commuting (−2.03), on his or her own, in the inner city, in a vehicle, on a cold, grey, early weekday morning¹⁰.

8.3.4 Robustness checks

We have performed a number of robustness checks on these findings regarding the positive links between SWB and EQ.

8.3.4.1 Landscape designations

As an alternative approach to identifying high-EQ locations, we re-ran the model replacing the LCM habitat variables with the three (in some cases overlapping) indicators of UK landscape designations discussed in [subsubsection 6.1.1.5](#): National Nature Reserves, National Parks, and Areas of Outstanding Natural Beauty.

Abbreviated model estimates are presented in [Table 8.17](#). All three designations are positively, significantly and substantially associated with happiness ratings. The effects of National Nature Reserves and National Parks are higher than those estimated for any land cover type but marine and coastal margins.

¹⁰Equivalently, this is a difference of about the same size as between being ill in bed (−19.65) versus doing physical exercise (+6.51), keeping all other factors the same.

Table 8.18: Land cover model — weekend and Bank Holiday responses only

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Land cover type when participant is outdoors</i>			
Continuous urban (base category)	—		
Marine and coastal margins	4.33	(0.87)	< 0.0001
Mountains, moors and heathland	0.98	(1.22)	0.4197
Woodland	1.60	(0.46)	0.0005
Semi-natural grasslands	1.22	(0.45)	0.0067
Enclosed farmland	1.65	(0.32)	< 0.0001
Freshwater, wetlands and flood plains	1.76	(0.96)	0.0671
Suburban/rural developed	0.53	(0.27)	0.0451
Inland bare ground	0.95	(0.75)	0.2053
All other variables from main land cover model, except weekend time-of-day dummies	Yes		
Observations	316059		
Groups (participants)	19561		
R ² (within groups)	11.4%		

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

8.3.4.2 Holidays

Although we include a wide range of control variables in our ESM happiness model, one factor we do not collect data on is whether participants are on holiday¹¹. Because participants may be more likely to visit remote high-EQ environments when on holiday, it is possible that the positive happiness effects we identify for natural environments could be partly due to such an effect. To address this issue we re-estimate the model using only responses received on weekends and Bank Holidays, when the great majority of respondents are ‘on holiday’ to the extent that they are free to engage in leisure activities.

This restriction reduces the response sample size by about two-thirds. Abbreviated estimates from the resulting model are shown in Table 8.18. All LCM type coefficients remain positive. Coefficients on all green and blue space types are reduced somewhat in magnitude, however, and those on the mountains, moors, heathlands and freshwater, wetlands, floodplains types are no longer significantly different from zero at the 5% level. It is possible that this loss of significance is simply due to the reduction in sample size.

This is by no means a perfect test, but the results would appear to indicate that, while the omission of a ‘holiday’ variable might account for some element of the positive EQ results obtained, green and blue space land cover types retain substantial positive links with happiness in and of themselves.

8.3.4.3 Validity criteria

As noted in subsection 8.1.3 we tested the effect of imposing more stringent response validity criteria, requiring responses to be made within 20 minutes of a signal instead of 60 minutes, and

¹¹In future work, we may add an item regarding holidays to the ESM survey (alongside other states, such as being drunk, hungover, hungry, or unwell) and/or investigate the use of heuristics, including distance from home and time since a ‘working, studying’ response, for identifying probable holiday responses.

Table 8.19: Land cover model — strict validity criteria (100m accuracy, 20 minute response)

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Land cover type when participant is outdoors</i>			
Continuous urban (base category)	—		
Marine and coastal margins	5.52	(0.83)	< 0.0001
Mountains, moors and heathland	2.41	(0.99)	0.0150
Woodland	2.11	(0.40)	< 0.0001
Semi-natural grasslands	2.00	(0.40)	< 0.0001
Enclosed farmland	2.16	(0.27)	< 0.0001
Freshwater, wetlands and flood plains	1.45	(0.73)	0.0462
Suburban/rural developed	0.85	(0.19)	< 0.0001
Inland bare ground	-0.047	(0.56)	0.9342
All other variables from main land cover model	Yes		
Observations	652736		
Groups (participants)	20648		
R ² (within groups)	13.1%		

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

reported accuracy to be 100m or better instead of 250m or better.

These criteria reduce the response sample size by just under half. Abridged model estimates are shown in [Table 8.19](#). The sign and significance of all LCM habitat variable coefficients is unchanged in this regression relative to that reported in [Table 8.16](#), and no coefficient varies by more than 0.5 between the two.

8.3.4.4 Happiness spikes

As noted in [subsubsection 8.2.2.3](#) there are spikes at the top and bottom of the reported happiness distribution, where the response slider has been moved all the way to the left or right. Arguably, these represent happiness self-ratings that are ‘off the scale’ — in other words, the true value is higher or lower than the observed value, which has been censored at the scale’s top or bottom limit.

Econometric models for use with censored cross-sectional data are available (e.g. Wooldridge, 2003, p. 579–583), as are random effects models for use with censored panel data (StataCorp, 2009a, p. 180 – 188). However, for censored panel data there are no conditional fixed effects models, and unconditional fixed effects estimates — such as could be obtained by simply including group dummy variables in a cross-sectional model — are biased (StataCorp, 2005)¹².

As discussed in [subsubsection 6.2.2.1](#), the standard fixed effects estimator allows for arbitrary correlation between any individual effects (including unobserved effects) and the observed explanatory variables, and we consider this an important property. Since there exist no fixed effects models for censored data, we therefore do not use a model for censored data as our primary model in the analyses reported above.

However, we assess the impact of censoring on our results by estimating cross-sectional and

¹²Group dummy variables cannot be used here in any case, since the number of dummies required is many times greater than Stata supports.

panel censored data models with the same specification as our main land cover model¹³. The two censored data models are presented in Appendix E.5 on page 433. In both cases the results follow a very similar pattern to those of the main land cover model, except that — as is intuitive, given the expanded effective range of the dependent variable — effect sizes are generally somewhat larger. This suggests that our main estimates are robust to the censoring of the dependent variable, and potentially somewhat conservative.

8.3.4.5 Econometric model

We estimated a model with the same specification as in Table 8.16 using OLS (in other words, this is our main fixed effects model minus the fixed effects). The results, which are tabulated in section E.6 of Appendix E, are very similar to those of the fixed effects model.

We ran an additional OLS model, also shown in section E.6, including participant-level variables that cannot be included in a fixed effects model. Again, coefficients on the response-level variables are very similar, while those on participant-level variables all conform to expectations from previous SWB research: higher incomes and marriage are linked to higher happiness, while unemployment, poor health, and long-term illness or disablement predict substantially lower happiness reports¹⁴.

8.3.4.6 Hypothesis testing

Finally, meaningful hypothesis testing requires that the significance level be a decreasing function of sample size (Leamer, 1978), and our sample size is very large. In addition, in interpreting our coefficients of interest, we are making multiple comparisons.

We can account for the first issue by using the natural log of the sample size as a higher-than-usual critical F value when testing whether each coefficient is different from zero (Deaton, 1997). We can account for the second using the Bonferroni correction, dividing the significance threshold ($p < 0.05$) by the number of tests (Abdi, 2007).

In our main land cover model, coefficients on all green or natural land cover types except two — again, freshwater and mountainous environments — retain significance even using the substantially more stringent thresholds calculated using these procedures.

8.4 Discussion

In this chapter we have reported on the findings of a unique investigation into links between EQ in an individual's immediate surroundings and his or her momentary happiness reports. We rely on a data set we have collected from thousands of volunteer participants, via their own mobile devices, using a novel spatial experience sampling technique.

Even after controlling for many other factors, participants are happier outdoors than indoors, and happier when outdoors in any kind of green or blue space than when outdoors in continuous urban environments. These green and blue spaces are not necessarily remote: urban parks are also recognised as such in our data. The relationships are highly statistically significant, and their magnitudes are substantial. The land cover type associated with the greatest happiness is marine and coastal margins, suggesting a strong link between immediate happiness and this variety of blue space.

Our findings appear robust to various alternative approaches. Land cover EQ variables remain significantly linked to happiness when we consider only weekend and Bank Holiday responses; exclude the spikes at the extremes of the response distribution; increase the stringency of our response time and location accuracy criteria for response validity; or account for the fact that we are making multiple comparisons using an extremely large data set. Furthermore, we find positive links of a similar magnitude when we substitute high-EQ landscape designation indicators for the land cover indicators of EQ.

¹³We use the INTREG and XTINTREG Stata commands (StataCorp, 2009a).

¹⁴The age variables are not significantly different from zero in this OLS specification, although they are significant in an alternative specification (not shown) from which health status indicators are omitted. In both cases, the coefficients define the classic U-shaped relationship of happiness with age, with its lowest point at around 40.

8.4.1 Causation

We know that the relationships we describe are not confounded at the participant level — that is, by associations between types of locations and types of people — because our model is estimated exclusively from the within-individual variation.

Omitted variables (endogeneity issues) remain a possibility, however, in this case at the level of experiences. Perhaps the likeliest candidates for unobserved characteristics of experience are certain temporary ongoing states — such as holidays, hangovers, or short periods of illness — that may be associated independently with changes in both happiness and exposure to EQ. Ideally, we might have included additional survey items addressing these. On the other hand, our weekends-only model still demonstrates highly significant EQ – SWB associations, and it would seem unlikely that such states are responsible for the whole of the effect we report.

Causal pathways may well run in both directions, such that people choose an environment partly according to their mood, and people's moods are partly determined by their environments. Although unproven, it seems both plausible and likely that the latter pathway — environment causing mood — is an important component of the relationship, particularly in the light of the findings of experimental/intervention studies mentioned in subsection 3.2.1. Future research might be able to provide greater assurance on this point either by identifying exogenous sources of variation in EQ exposure or, where the temporal resolution of data is high enough, by careful analysis of sequences of change (for example, is it unhappy → green space → happy, or unhappy → happy → green space?).

8.4.2 Generalisation

Our sample in this research is limited to individuals who have iPhones, who encounter the opportunity to participate in the study, and who then self-select. We therefore did not expect to obtain a sample that is representative of the population as a whole and, as seen in subsubsection 8.2.1.4, we indeed did not. Caution is therefore required in making any claims as to the general applicability of our results.

We know of no particular reason to expect that the demographic peculiarities of our sample — who are younger, richer, and better educated than average — will affect our estimates of relationships between SWB and EQ. These differences might mean they are exposed to a somewhat different selection of environments, however¹⁵.

Self-selection could affect our findings if there are meaningful differentials in individuals' sensitivity to the EQ characteristics we examine, and if these differentials play a part in individuals' decisions to participate in the study. We cannot tell how far this restricts the potential to generalise from our results.

8.4.3 Comparison with previous findings

Since our research methods and hypothesis are novel, comparisons with previous research will necessarily be indirect. Our findings do appear consistent with the theory and experimental evidence outlined in chapter 3, and potentially provide some support for the applicability of the findings of experimental studies — in which a brief exposure to nature improves SWB — to everyday life.

Hedonic pricing studies such as those by Gibbons et al. (2011) and Smith (2010) have found that EQ of the kind we examine is capitalised in property prices; since proximity is likely to facilitate exposure, these positive values for nearby EQ seem generally consistent with our findings on happiness and immediate experience. Effects for specific land cover types are not quite aligned, however: our most strongly SWB-predicting type, marine and coastal margins, is not significant in Gibbons et al.'s price model, and their most strongly price-predicting type, freshwater, wetlands

¹⁵For example, it might be that our base category urban environments are, in fact, nicer than the average, which could lead to an underestimation of the positive links with other land cover types.

and floodplains, has one of the smallest effects on SWB in our model. There are many potential explanations for this discrepancy¹⁶.

The most relevant comparators from our web survey research strand, described in the previous chapter, are the UK-wide findings. These again use the same land cover EQ data we use here, and the comparison again shows agreement as to generalities — some green and blue land cover types are positively linked to SWB — although the specific types do not tally. We find all of the types that are significant in either the survey-based life satisfaction or affective indicator models significant in our ESM-based immediate happiness model. Again, however, the strongest predictor type for immediate happiness in our ESM study, marine and coastal margins, is not significant in either of the survey-based models.

8.4.4 Summary

In summary, this chapter has reported on the application of a novel research method to test a new hypothesis in EQ and SWB research. This method has significant advantages over the conventional cross-sectional survey-based approach.

We are able to gather an extremely large sample, so that even relatively small effects may be identifiable. The use of satellite positioning (GPS) provides us with accurate and objective data on participants' actual locations, including when they are outdoors. This allows us to calculate particularly convincing indicators of EQ exposure. We use fixed effects to eliminate from our models all individual characteristics that are invariant over the period of study — which may include personality characteristics, wealth, and varying interpretations of the subjective response scale (the reporting function $R(\cdot)$ discussed in [subsubsection 2.1.1.2](#)). We can therefore be confident that our results are not confounded by individual-level factors varying in tandem with home-area EQ. Finally, spatial sorting issues are eliminated because we observe individuals in a variety of locations with differing EQ.

Using this method, we find that momentary happiness is positively associated with all green and blue space land cover types. We believe that this work represents a new and promising line of evidence on relationships between SWB and EQ.

¹⁶For example, people might be mis-predicting the utility effects of different land cover types when making house-buying decisions; different land cover types might have genuinely different effects on momentary happiness vs. (preference satisfaction) utility; and/or there may be biases from omitted variables in either or both studies. There could also be specific factors affecting house prices in relation to specific land cover types: for example, house prices in marine and coastal margin locations might be depressed by flood risk.

Chapter 9

Synthesis and conclusions

Subjective wellbeing or happiness is a topic of growing interest in economics, not least amongst researchers concerned with the quality of the environment, as was discussed in [chapter 2](#). There are a number of reasons for hypothesising that higher EQ will lead to greater wellbeing. There is some existing evidence — from studies in the economics of happiness, other areas of economics, and other disciplines — that this is indeed the case. These reasons, and this evidence, were discussed in [chapter 3](#).

The previous research in happiness economics covers a range of EQ characteristics, but its methodology is in many cases somewhat crude. It has relied on simple cross-sectional analyses, asking either whether the average of people's retrospective happiness reports in a country is related to aggregate EQ indicators in that country, or whether a person's retrospectively-assessed happiness is related to EQ characteristics around his or her home. Even in the latter case, studies have sometimes included only a narrow range of EQ characteristics, aggregated over relatively large areas. As indicated in [chapter 1](#), this thesis has taken two approaches to improving on this research.

Our first, incremental, approach was to stick to the cross-sectional study design while improving the resolution and (in some cases) range of data and measurements on EQ and SWB. We found some positive links between SWB reports and some types of green and blue space across the UK as a whole, and some evidence of differing effects on different elements or indicators of SWB.

On the other hand, these results were not enormously robust; we found no links between SWB and workplace EQ; and in London we found no links at all. We suspect that this is due at least in part to the limitations of the conventional, cross-sectional study design. It may be unrealistic to hope to pick out the effects of multiple, partially correlated spatial characteristics amongst the noise of individual-level unobservables (such as personality, wealth, and recent life events); in the potential presence of sorting by EQ sensitivity in individuals' home location choices; and given the indirect relationship between simple levels of, and actual exposure to or use of, EQ.

Our second approach was thus somewhat more radical. We posed a slightly different question: is a person's *momentary* happiness related to EQ in his or her *immediate* surroundings? To address this question, we developed and implemented a new method of data collection: crowd-sourced, spatial experience sampling, using an app for individuals' own GPS-equipped mobile phones.

The principal limitation of this strand of our study is sampling: we rely on a convenience sample of users of a specific smartphone. It is not obvious, though, that EQ will affect these individuals differently to others. Meanwhile, the great benefit of this method is that it provides a large panel data set, comprising many precisely geo-located responses from each of many individuals. We are able to use this data to ameliorate many of the problems identified with the conventional approach.

Our results using this approach are strong and intuitive. Even after controlling for a range of other spatial and non-spatial factors, participants are substantially happier when outdoors in any green or blue space land cover type than when they are outdoors in a continuous urban environment. These results are robust to estimation with a variety of different models, specifications and sample restrictions.

As discussed in [subsection 2.2.1](#) regarding wellbeing, the questions addressed by the two strands of this thesis — which concern retrospective and immediate quantities respectively — are

undoubtedly distinct. On the other hand, broadly comparable answers to those questions would not seem greatly surprising. For both happiness and EQ indicators, we can expect immediate and retrospective quantities to be linked: an individual who experiences more positive moments is likely to come to a more positive evaluation of his or her life, and an individual living in a high-EQ location is more likely to use and be exposed to higher EQ¹.

Unfortunately, our survey-based results are not strong enough to permit detailed comparison of the retrospective and immediate relationships. We can say, however, that the findings of the two approaches appear generally compatible: in each case, green and blue spaces have a measurably positive impact on wellbeing.

There is considerable scope for both approaches to be developed further and answers to both questions to be further refined. As discussed further below, the spatial experience sampling method appears to offer particularly great scope for advancing understanding in this field.

9.1 Original contribution

9.1.1 Research methods

Both of our approaches share important limitations with the earlier work in this area, particularly with regard to questions of causality and the potential for omitted variables biases. Nevertheless, we believe that each contributes significant methodological advances beyond the previous state of the art.

Our survey-based research on retrospective happiness evaluations (chapters 4, 6 and 7) offers several incremental improvements on the methods that have conventionally been applied in the happiness economics literature on EQ, which were critically evaluated in [subsubsection 3.2.3.1](#).

We join very high resolution spatial data with very precise location information, where most existing studies have had data only at ward level (or worse). We use more advanced GIS methods, calculating weighted proportions of land cover types within a certain radius of respondents' locations. We consider multiple EQ characteristics simultaneously, and explore a number of EQ characteristics which have not previously been looked at, including the accessibility of green and blue space. We estimate SWB models including EQ characteristics not only at respondents' homes, but also at their workplaces. We compare the results of using several alternative SWB indicators, and we follow a number of the recommendations for high-quality SWB valuation research emerging from the most recent valuation literature (reviewed in [subsection 2.2.3](#)).

We hope and expect that future research in this area will build on these improvements, particularly with the increasing availability of high-resolution data sources and powerful GIS tools. We hope also that future studies across disciplines will make use of the flexible web survey software developed for this study, including its ability to prompt for very precise location data, as discussed in [subsection 4.3.1](#).

Our spatial ESM study (chapters 5, 6 and 8) is a novel and more radical departure from the happiness economics literature, taking as its starting point the work within psychology on experience sampling outlined in [subsubsection 2.2.1.2](#). We have successfully implemented a GPS-enabled, mobile app-based experience sampling system of some complexity at a very large scale, demonstrating that this is feasible with respect both to the technology and to the recruitment and retention of participant volunteers².

The major limitation of this method as applied today — having to sample from a restricted pool of smartphone owners, resulting in the sample biases noted in [subsubsection 8.2.1.4](#) — seems likely to all but disappear in the medium-term, as smartphones attain greater market penetration at all income levels (the smartphone market is predicted to grow by 50% worldwide in 2011 alone — [IDC, 2011](#)).

There are a huge number of ways to extend and apply this methodology more broadly to questions regarding EQ and happiness, using our existing data, new data from the *Mappiness* project, or new data from new studies. We discuss these further in [section 9.2](#). There are also possibilities for much wider application of this methodology, and we touch on some of these in [section 9.3](#).

¹In the latter case, choice of residential location according to EQ sensitivity may mean that cause-and-effect runs both ways.

²One commercial research professional told the researcher that *Mappiness* has “taken the risk out of” embarking on projects of this sort.

9.1.2 Happiness and environmental quality

We contribute to the state of knowledge regarding quantitative links between happiness and EQ in two ways.

We present new evidence at national level that certain types of green and blue spaces near the home are linked to retrospective evaluations indicating higher life satisfaction, greater emotional wellbeing, and lesser negative affect. This evidence is not exceptionally robust, but for life satisfaction it is the first available on this question — a gap in the literature identified in chapter 3 — and has significant potential for elaboration in future research.

We provide much stronger evidence on the related point that people are happy when they are in green and blue spaces. The effects we describe are both substantial and highly robust. This constitutes a completely new line of evidence in EQ and wellbeing research, as has been noted previously. As discussed further below, it has significant implications beyond academic work.

9.2 Future directions

In relation to both types of research, we have identified causality and omitted variables as remaining challenges. For questions of causality, exogenous variation is key. Such variation in most EQ exposures remains difficult to identify, but researchers must remain alert to it (for example, the abolition of the western extension of London's Congestion Charging zone, or the closure of Greenwich Park during the 2012 Olympics, could be investigated as possible candidates). In principle, spatial econometric models could help mitigate omitted variables issues. To date, only one application of these models to SWB and EQ is known (Rehdanz, 2007), and as noted in subsection 3.2.3 this study has only country-level data on EQ.

In relation to research using retrospective happiness data, more work is still needed to bring down the high values invariably calculated using the SWB valuation technique, an issue discussed in subsection 2.2.3.

As noted above, we are particularly optimistic regarding the prospects for future research using immediate data and the spatial experience sampling technique. It is a new method, and offers the promise of low-hanging fruit. Below, we list ideas for potential extensions on the work we have presented. Time constraints — partly imposed by the unavailability of the necessary consumer technology at the start of the research process — prevented some of these points from being addressed within this thesis.

9.2.1 Spatial ESM data

The spatial ESM data collection technique could be extended in a number of ways.

Platforms Additional platforms could be supported (such as the wide variety of Android³ handsets), to provide wider coverage of the population and in some cases additional capabilities⁴.

Signalling The system could be reimplemented so that signalling did not require a data connection, in order to obtain more responses from remote (high-EQ, low-mobile Internet) locations⁵. As some participants have requested, follow-up reminder signals could be provided, improving the chances of a response. In addition, other signalling schemes, such as location-contingent signalling, could be explored.

ESM questions Additional ESM assessment questions could be asked, to give finer categorisation of activities and location types, and to assess short- and medium-term states. A branching and/or contextual question path could help to keep the response process speedy in spite of such additions. In the light of how long some people appear willing to take part in

³Android is an open-source smartphone operating system, supported by Google, which powers handsets from a number of manufacturers.

⁴Apple's iOS does not permit app code to execute except when launched by the user; Android, for example, does not impose this restriction.

⁵This is possible on Android handsets and on the iPhone beginning with iOS version 4.

these studies, it would also be desirable to provide a means for participants to update demographic information (employment, relationship status, income, and so on) and to provide information on unusual but significant events (redundancy or bereavement, for example).

Sensor data Contributed photos could be coded — either manually or using computer vision techniques — to provide additional data on EQ, such as the aesthetic character of urban spaces. The app could be enhanced to register not only an overall noise level, but information that could allow different kinds of noise sources (such as traffic, music, or conversation) to be distinguished. Digital compass and accelerometer data could be gathered, where available, to assess physical activity levels. And subject to participants' consent, location data could be collected more frequently — for example, on the hour, or every 5 minutes for the hour prior to signalling. This would also provide data to help model factors affecting the probability of response.

External data Data on other types of EQ could usefully be exploited, such as historical air pollution concentrations by both location and time.

9.2.2 Spatial ESM analysis

The analysis of this and similar data could also be taken much further.

More advanced econometric models, accounting for spatial and/or serial autocorrelation, could be estimated from the data. The assumption of independent effects we have made in relation to most of our explanatory variables could be relaxed, and the huge variety of possible interactions be investigated. Analyses could be compared across population sub-groups, between urban and rural environments, or by geographical region.

Relative levels or contrasts could be explored, such as between the immediate environment and the environment around the home. Retrospective happiness evaluations provided on sign-up could be compared with the momentary happiness data, providing more information on relations between the two. Similarly, the extent to which EQ levels around participants' homes tally with the levels experienced during sampling could also be studied.

The trajectories of individuals' response sequences could also be analysed in more detail, to discover whether and how participants learn and update their preferences as a result of taking part. Our data set might profitably also be used to investigate the rate and extent of habituation to different characteristics of EQ.

It would also be constructive to explore the use of this spatial ESM data for monetary valuation. For example, the known costs of certain paid activities (e.g. cinema attendance) might be used to provide a lower bound on WTP for experiences of high-EQ environments. Income information might also be used, although it is unclear whether conventional WTP values might be derived in this way.

9.3 Wider implications

9.3.1 Experience sampling research

Crowd-sourced, mobile and spatial ESM techniques could be adapted to many other questions in both academic and commercial research. We have already been approached by computer scientists studying spatial recommendation systems, policymakers at the Department for Transport, advertising agencies (interested in people's moods around their hoardings), consultancies wishing to measure workforce satisfaction, and others. We anticipate probable future applications also to questions of health and physical exercise, urban planning, consumer behaviour, and more.

9.3.2 Planning and policy

We show that people are happier in green and blue spaces than in continuous urban environments. Evidence on this topic may be of interest to those concerned with natural and built environments

— such as conservationists, landscape architects and urban planners — and to those engaged with issues of mental health and wellbeing.

Such evidence also has the ability to inform planning and policy development at all levels: it could be used in the evaluation of such schemes as the imminent removal of 'brownfield' housing development targets for local authorities ([DCLG, 2011](#), p. 49) and recent proposals to dispose of much of the UK's publicly-held woodland ([Forestry Commission & Defra, 2011](#)).

The findings presented here are not yet ready to be used in the evaluation of specific policies, but in broad terms they strengthen the evidence that environmental links with happiness are real, measurable and substantial. They might encourage policymakers to take seriously the public provision of green and blue spaces, and the promotion and facilitation of their use.

We believe that this research offers a valuable new way for policymakers and researchers to ask and answer questions about happiness and environmental quality, and we hope and intend that it will be developed further.

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Appendix A

Supplementary information for survey methods

A.1 Quota cell sizes and response statistics

The tables below display statistics provided by the *websperiment* survey quota system, and may be interpreted as follows:

required The number of respondents we have calculated should be classified in this quota cell in order to be representative of the population as a whole.

completed The number of valid completed surveys from respondents falling within this quota cell.

remaining The number of required respondents minus the number of completed surveys.

recently started The number of incomplete surveys that may still be in progress from respondents in this quota cell.

dropped out The number of respondents in this quota cell who began the survey but did not complete it.

turned away The number of respondents in this quota cell who visited the survey after the quota cell had been filled.

manually excluded The number of respondents in this quota cell whose survey responses were excluded from the study for reasons discussed in [section 4.6](#), and thus were not counted towards the number of valid completed surveys.

A.1.1 London

age	work_income	location	sex	required	completed	remaining	recently started	dropped out	turned away	manually excluded
age_16_to_34	not_employee	inner_london	male	48	41	7	0	6	0	11
			female	55	60	-5	0	9	81	6
		outer_london	male	51	51	0	0	3	16	9
			female	55	63	-8	0	12	193	3
		elsewhere_or_not_sure	male	0	0	0	0	0	51	0
			female	0	0	0	0	0	60	0
	below_median	inner_london	male	16	16	0	0	0	6	1
			female	19	20	-1	0	0	59	1
		outer_london	male	29	29	0	0	1	22	2
			female	25	25	0	0	2	94	0
		elsewhere_or_not_sure	male	0	0	0	0	0	17	0
			female	0	0	0	0	0	28	0
age_35_to_54	not_employee	inner_london	male	33	31	2	0	8	0	1
			female	39	41	-2	0	5	38	2
		outer_london	male	48	48	0	0	5	8	0
			female	49	58	-9	0	6	123	0
		elsewhere_or_not_sure	male	0	0	0	0	0	102	0
			female	0	0	0	0	0	53	0
	below_median	inner_london	male	16	15	1	0	2	0	1
			female	12	12	0	0	1	32	0
		outer_london	male	15	15	0	0	4	19	0
			female	37	37	0	0	0	66	0
		elsewhere_or_not_sure	male	0	0	0	0	0	13	0
			female	0	0	0	0	0	35	0
above_median	not_employee	inner_london	male	18	18	0	0	2	14	1
			female	17	17	0	0	2	16	0
		outer_london	male	41	41	0	0	0	24	6
			female	22	22	0	0	1	47	1
		elsewhere_or_not_sure	male	0	0	0	0	0	24	0
			female	0	0	0	0	0	19	0
	not_sure	inner_london	male	0	0	0	0	0	2	0
			female	0	0	0	0	0	5	0
		outer_london	male	0	0	0	0	0	5	0
			female	0	0	0	0	0	17	0
		elsewhere_or_not_sure	male	0	0	0	0	0	6	0
			female	0	0	0	0	0	11	0

age	work_income	location	sex	required	completed	remaining	recently started	dropped out	turned away	manually excluded								
age_55_plus	not_employee	inner_london	male	28	27	1	0	3	1	1								
			female	42	37	5	0	1	0	1								
		outer_london	male	69	69	0	0	15	0	3								
		elsewhere_or_not_sure	female	85	85	0	0	10	25	1								
		elsewhere_or_not_sure	male	0	0	0	0	0	124	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	43	0								
	below_median	inner_london	male	4	3	1	0	0	0	0								
			female	5	5	0	0	0	4	0								
		outer_london	male	5	4	1	0	1	5	0								
			female	13	13	0	0	2	12	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	11	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	5	0								
above_median	inner_london	male	4	4	0	0	2	5	0	0								
		male	1	1	0	0	1	0	0	0								
		outer_london	male	10	10	0	0	0	4	0								
			female	5	4	1	0	0	5	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	6	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	4	0								
	not_sure	inner_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	2	0								
		outer_london	male	0	0	0	0	0	1	0								
			female	0	0	0	0	0	9	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	1	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	5	0								
under_16	not_employee	inner_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	1	0								
		outer_london	male	0	0	0	0	0	1	0								
			female	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	1	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	2	0								
	below_median	inner_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	0	0								
		outer_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	0	0								
	above_median	inner_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	0	0								
		outer_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	0	0								
	not_sure	inner_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	0	0								
		outer_london	male	0	0	0	0	0	0	0								
			female	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	male	0	0	0	0	0	0	0								
		elsewhere_or_not_sure	female	0	0	0	0	0	0	0								
column totals																		
				required		completed		remaining		recently started		dropped out		turned away		manually excluded		
				1001		1008		19		0		114		1746		64		

A.1.2 UK

age	gender	employment	region	required	completed	remaining	recently started	dropped out	turned away	manually excluded
age_16_to_34	male	employee	north	38	38	0	0	3	14	7
			midlands_east	36	36	0	0	4	19	7
			london	22	22	0	0	1	29	4
			south	34	34	0	0	4	16	4
			scotwalni	23	23	0	0	0	13	1
			unknown	0	0	0	0	1	1	0
	not_employee		north	37	37	0	0	6	10	6
			midlands_east	35	35	0	0	4	14	4
			london	24	24	0	0	5	3	6
			south	28	28	0	0	3	13	8
			scotwalni	22	22	0	0	3	0	6
			unknown	0	0	0	0	0	0	0
age_35_to_54	female	employee	north	37	37	0	0	0	50	6
			midlands_east	34	34	0	0	3	42	5
			london	20	20	0	0	0	41	1
			south	33	33	0	0	4	45	2
			scotwalni	23	23	0	0	6	30	3
			unknown	0	0	0	0	0	0	0
	not_employee		north	37	37	0	0	3	50	6
			midlands_east	36	36	0	0	5	51	2
			london	27	27	0	0	4	24	1
			south	28	28	0	0	2	43	3
			scotwalni	22	22	0	0	2	29	3
			unknown	0	0	0	0	0	0	0

age	gender	employment	region	required	completed	remaining	recently started	dropped out	turned away	manually excluded		
age_55_plus	male	employee	north	16	16	0	0	1	32	0		
			midlands_east	18	18	0	0	2	31	1		
			london	6	6	0	0	0	7	0		
			south	17	17	0	0	0	29	0		
			scotwalni	10	10	0	0	0	21	0		
			unknown	0	0	0	0	0	0	0		
	not_employee		north	65	66	-1	0	4	80	0		
			midlands_east	70	70	0	0	1	75	2		
			london	24	24	0	0	1	28	0		
			south	62	63	-1	0	3	87	1		
			scotwalni	45	45	0	0	5	29	1		
			unknown	0	0	0	0	0	0	0		
under_16	male	employee	north	15	15	0	0	0	21	0		
			midlands_east	16	16	0	0	0	2	1		
			london	6	6	0	0	1	10	0		
			south	16	16	0	0	0	14	0		
			scotwalni	10	10	0	0	1	0	0		
	not_employee		north	80	63	17	0	3	0	0		
			midlands_east	85	85	0	0	4	3	2		
			london	30	23	7	0	4	0	1		
			south	76	76	0	0	2	18	2		
			scotwalni	56	52	4	0	1	0	1		
			unknown	0	0	0	0	0	0	0		
			north	0	0	0	0	0	0	0		
			midlands_east	0	0	0	0	0	4	0		
			london	0	0	0	0	0	3	0		
			south	0	0	0	0	0	2	0		
			scotwalni	0	0	0	0	0	1	0		
			unknown	0	0	0	0	0	0	0		
female	male	employee	north	0	0	0	0	0	0	0		
			midlands_east	0	0	0	0	0	1	0		
			london	0	0	0	0	0	1	0		
			south	0	0	0	0	0	0	0		
			scotwalni	0	0	0	0	0	0	0		
	not_employee		north	0	0	0	0	0	0	0		
			midlands_east	0	0	0	0	0	4	0		
			london	0	0	0	0	0	3	0		
			south	0	0	0	0	0	2	0		
			scotwalni	0	0	0	0	0	1	0		
			unknown	0	0	0	0	0	0	0		
			north	0	0	0	0	0	0	0		
			midlands_east	0	0	0	0	0	0	0		
			london	0	0	0	0	0	0	0		
			south	0	0	0	0	0	0	0		
			scotwalni	0	0	0	0	0	0	0		
			unknown	0	0	0	0	0	0	0		
			north	0	0	0	0	0	3	0		
			midlands_east	0	0	0	0	0	3	0		
			london	0	0	0	0	0	3	0		
			south	0	0	0	0	0	1	0		
			scotwalni	0	0	0	0	0	1	0		
			unknown	0	0	0	0	0	0	0		
column totals												
				required	completed	remaining	recently started	dropped out	turned away	manually excluded		
column totals				2000	1976	28	0	138	2403	122		

A.2 Sample invitation email

From: Toluna <survey@toluna.com>
Subject: A survey about wellbeing worth 5000 points!
Date: 13 August 2009 20:00:39 GMT+01:00
To: george@beyond-waste.com
Reply-To: survey@toluna.com



Survey ID: **SO-18716**
Number of points: **5000 points**
Survey closing date: **17.08.2009**
(or as soon as we have the number of respondents that we are looking for)
Length of the survey: **15 minutes**

Dear member,

Your opinion is very valuable for us. Today we are asking you to participate in a survey giving you the chance to earn **5000 extra points!**

If you are unfortunately not part of the target group we are looking for in this survey, the questionnaire will finish before the end. You will still be able to access other surveys later and you will be given a free ticket for the Incredible **£5000 Monthly Prize Draw**, as a token of our appreciation.

Click here to proceed to the questionnaire

If the link does not work please paste the link below to your browser :
<http://as.automatesurvey.com/SOP/P299943697303072S2P?userid=6660401>

Thank you very much,
The Toluna Team.

PS: Please note that there are quality check questions in this survey, so please read each question carefully and choose the answer that best describes your opinion.

Your points will be credited to you within 4 weeks following the end of the survey.

We kindly ask you to activate JavaScript and to accept cookies in your internet browser.

You received this invitation email because you are a registered member of Toluna. If you no longer wish to receive invitations to participate in our studies, please click here to cancel your membership: [Unsubscribe](#).

Please do not reply to this message. If you have any queries, please use [our contact form](#).

PS: Please do not forget to save survey@toluna.com in your email address book so that your email server doesn't classify our invitations as spam or junk mail.

[Terms and conditions](#)

A.3 Survey screenshots

These screenshots show every survey page, including those that were only displayed to some respondents based on earlier responses. However, they do not show all items on every page in cases where items could be shown or hidden dynamically based on earlier responses.

A.3.1 London

Welcome



Thank you for your interest in this survey, which is:

- about your wellbeing ...
- ... and a wide range of other things that could affect it.
- 15 – 20 minutes long.
- anonymous, confidential and secure.
- part of a research project at The London School of Economics (LSE).

Your completion of the survey represents your consent to serve as a subject in our research study. If you're under 18, please get consent from a parent or guardian before continuing.

 **Want to know more?** [See more details now](#), or click 'Help & information' at the top right of any page.

[Start survey »](#)

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Help & information

What will I be asked?

The first 40% or so of the survey has questions about your general wellbeing and life satisfaction.

 Got a question, concern, comment, or technical problem?
Please don't hesitate to contact us.
• Email: info.en@toluna.com

The remaining 60% is about a wide range of other things that might be connected to your wellbeing. This part includes questions on: health & lifestyle, relation to nature, basic demographics (age, sex, employment, income, etc.), your home and local area, religion, politics, family background, and a few others.

What will you do with my responses?

We're looking at people's wellbeing in London and how this may be connected to a wide range of different factors. Once everyone has completed the survey, we'll use various statistical methods to see what their combined responses can tell us about these relationships.

If you're curious to see what we find, please come back from time to time. We'll make our findings available here—<http://www.wellbeingsurvey.org.uk>—as soon as they're ready. We also hope to present our findings in academic journals and conferences, and to make sure policy makers are aware of anything relevant.

In any case, we'll never show any individual's responses—only information at the group level.

Will you know who I am?

No. We don't ask for your name or contact information at any point. Some of the information we do ask for could in principle be used to help identify you, but we promise never to use it for this purpose, and we'll never disclose it to anyone else.

Is my information secure?

Yes. The survey is conducted over a secure *https* connection, the same kind used for online banking and shopping. The information you give will be stored on our secure computer systems, accessible only to us.

Who are you?

We're [George MacKerron](#) and [Dr Susana Mourato](#),
researchers in the [Department of Geography & Environment](#) at the [London School of Economics](#).



*Department of Geography & Environment
London School of Economics
Houghton Street
London WC2A 2AE*

Please [close this window or tab](#) to return to the survey.

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Wellbeing survey – LSE

[progress bar] 3% complete

[Help & information](#)

Basic information (1)

Are you male or female?

- Male
 Female

What is your age?

Please select...

Which of these best describes your current situation?

- Self employed
 In paid employment (full- or part-time)
 Unemployed and seeking work
 Retired from paid work altogether
 On maternity leave
 Full-time student or at school
 On a government training scheme
 Looking after family or home
 Caring for a sick, elderly or disabled person
 Long term sick or disabled
 Something else

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SA-3

SA-4

Basic information (2)

What are your **gross** earnings in your **main (or only) job**?

- £470 a week / £2,040 a month / £24,500 a year or less
 - More than £470 a week / £2,040 a month / £24,500 a year
 - Not sure
-

Are you **currently** living in Greater London?

Yes – I'm living in...

- | | | |
|--|--|---|
| <input type="radio"/> Barking and Dagenham | <input type="radio"/> Fulham (and Hammersmith) | <input type="radio"/> Lewisham |
| <input type="radio"/> Barnet | <input type="radio"/> Greenwich | <input type="radio"/> Merton |
| <input type="radio"/> Bexley | <input type="radio"/> Hackney | <input type="radio"/> Newham |
| <input type="radio"/> Brent | <input type="radio"/> Hammersmith and Fulham | <input type="radio"/> Redbridge |
| <input type="radio"/> Bromley | <input type="radio"/> Haringey | <input type="radio"/> Richmond upon Thames |
| <input type="radio"/> Camden | <input type="radio"/> Harrow | <input type="radio"/> Southwark |
| <input type="radio"/> Chelsea (and Kensington) | <input type="radio"/> Havering | <input type="radio"/> Sutton |
| <input type="radio"/> City of London | <input type="radio"/> Hillingdon | <input type="radio"/> Tower Hamlets |
| <input type="radio"/> City of Westminster | <input type="radio"/> Hounslow | <input type="radio"/> Waltham Forest |
| <input type="radio"/> Croydon | <input type="radio"/> Islington | <input type="radio"/> Wandsworth |
| <input type="radio"/> Dagenham (and Barking) | <input type="radio"/> Kensington and Chelsea | <input type="radio"/> Westminster (City of) |
| <input type="radio"/> Ealing | <input type="radio"/> Kingston upon Thames | <input type="radio"/> Lambeth |
| <input type="radio"/> Enfield | | |

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No/not sure

- No, I'm living somewhere else at the moment
 - Not sure
-

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 5% complete[Help & information](#) 

Satisfaction with life

All things considered, how satisfied are you with your life as a whole nowadays?

[* add a comment](#)[« Previous](#)[Next page »](#) 5% complete[Help & information](#) 

 **You may have missed something.** Please check your answers below.

Satisfaction with life

All things considered, how satisfied are you with your life as a whole nowadays?



 We would be very grateful if you would provide a response to this question: it represents a key part of our research topic.

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Life satisfaction of others

On this page we very briefly describe four people's lives. Please read the descriptions carefully, and try to imagine how satisfied with their lives these people might be.

i **There are no right or wrong answers**—we'd just like to know your impressions based on the information given.

Sam is 33 years old. She got divorced 2 years ago, and during the week she looks after her 9-year-old son on her own. Sam earns £20,000 a year in a public sector job. She's in good health, and has a circle of close friends whom she sees fairly regularly.

How satisfied with her life as a whole do you think Sam is?



Liz is 58 years old. She's married, with two grown-up children, and works for a large, successful firm. She and her husband have a combined income of £200,000 a year. They entertain or go out with friends once or twice a week, and take several holidays a year. Liz is close to her family, and looks forward to seeing more of her grandchildren when she retires.

How satisfied with her life as a whole do you think Liz is?



Stephen is 42 years old. He's single, and has no children. He makes £70,000 a year in a professional job, but some colleagues have recently been laid off and his position isn't secure. Outside work Stephen watches a lot of television, and sees friends for a drink about once a month. He's slightly overweight, and carries an inhaler for his asthma.

How satisfied with his life as a whole do you think Stephen is?

Extremely

Extremely



Rajiv is 25 years old. He's married, without children, and works full-time from home. Between them, he and his wife bring home £40,000 a year. They go out with family or friends most weeks. Rajiv keeps in good shape, and plays football most weekends.

How satisfied with his life as a whole do you think Rajiv is?



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Wellbeing

Over the next few pages we'll ask some more questions about how you feel about yourself and your life. Again, there are no right or wrong answers.

 **Some questions may seem a bit similar to each other**, but please bear with us. Try to consider each question in its own right.

Please say how much you agree or disagree with each of the following statements.

I'm always optimistic about my future

<input type="radio"/> Disagree strongly	<input type="radio"/> Disagree	<input type="radio"/> Neither agree nor disagree	<input type="radio"/> Agree	<input type="radio"/> Agree strongly
--	-----------------------------------	---	--------------------------------	---

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In general I feel very positive about myself

<input type="radio"/> Disagree strongly	<input type="radio"/> Disagree	<input type="radio"/> Neither agree nor disagree	<input type="radio"/> Agree	<input type="radio"/> Agree strongly
--	-----------------------------------	---	--------------------------------	---

At times I feel as if I am a failure

<input type="radio"/> Disagree strongly	<input type="radio"/> Disagree	<input type="radio"/> Neither agree nor disagree	<input type="radio"/> Agree	<input type="radio"/> Agree strongly
--	-----------------------------------	---	--------------------------------	---

On the whole my life is close to how I would like it to be

<input type="radio"/> Disagree strongly	<input type="radio"/> Disagree	<input type="radio"/> Neither agree nor disagree	<input type="radio"/> Agree	<input type="radio"/> Agree strongly
--	-----------------------------------	---	--------------------------------	---

Taking all things together, how happy would you say you are?



* add a comment

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Wellbeing (2/7)

Please tell us how much of the time **during the past week...**

... you felt depressed?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you felt that everything you did was an effort?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... your sleep was restless?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you were happy?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you felt lonely?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you enjoyed life?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you felt sad?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you couldn't get going?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

And please tell us how much of the time **during the past week...**

... you had a lot of energy?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you felt anxious?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you felt tired?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you were absorbed in what you were doing?

<input type="radio"/>	None or almost none of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	All or almost all of the time
-----------------------	---------------------------------	-----------------------	------------------	-----------------------	------------------	-----------------------	-------------------------------

... you felt calm and peaceful?

None or almost none of the time Some of the time Most of the time All or almost all of the time

... you felt bored?

None or almost none of the time Some of the time Most of the time All or almost all of the time

... you felt really rested when you woke up in the morning?

None or almost none of the time Some of the time Most of the time All or almost all of the time

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Wellbeing (3/7)

To what extent do you agree or disagree with each of the following statements?

I feel I am free to decide for myself how to live my life

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

In my daily life, I seldom have time to do the things I really enjoy

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

In my daily life I get very little chance to show how capable I am

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I love learning new things

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

Most days I feel a sense of accomplishment from what I do

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I like planning and preparing for the future

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

When things go wrong in my life, it generally takes me a long time to get back to normal

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

My life involves a lot of physical activity

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

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Wellbeing (4/7)

How satisfied are you with how your life has turned out so far?



And how satisfied are you with your present standard of living (material circumstances)?



How often do you meet **socially** with friends, relatives or work colleagues?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

Do you have anyone with whom you can discuss intimate and personal matters?

- Yes
- No

How much of the time spent with your immediate family (children, parents, siblings and partner) is...

... enjoyable?

None of the time	All of the time	Doesn't apply				
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6

... stressful?

None of the time	All of the time	Doesn't apply				
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6

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Wellbeing survey – LSE

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Wellbeing (5/7)

Please tell us to what extent...

... you get a chance to learn new things?

Not at all	A great deal					
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6

... you feel that people in your local area help one another?

Not at all	A great deal					
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6

... you feel that people treat you with respect?

Not at all	A great deal					
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6

... you feel that people treat you unfairly?

Not at all	A great deal					
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6

... you feel that you get the recognition you deserve for what you do?

Not at all	A great deal					
<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6
0	1	2	3	4	5	6



Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?



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Wellbeing survey – LSE

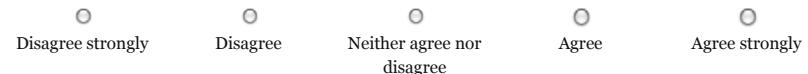
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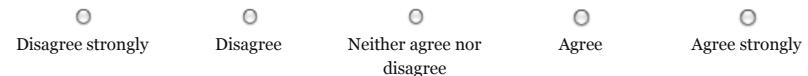
Wellbeing (6/7)

Please say to what extent you agree or disagree with each of the following statements.

I generally feel that what I do in my life is valuable and worthwhile



If I help someone I expect some help in return



The way things are now, I find it hard to be hopeful about the future of the world



There are people in my life who really care about me



For most people in Britain, life is getting worse rather than better



I feel close to the people in my local area

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

Do you ever feel frustrated by having watched too much television?

- Yes, often
- Yes, sometimes
- Occasionally
- No, never
- Never watch TV

Are you currently in paid work of any kind?

- Yes
- No

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Wellbeing survey – LSE

 34% complete

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Wellbeing (7/7)

All things considered, how satisfied are you with your present job?

If you have more than one job, please answer about your main job.



How satisfied are you with the balance between the time you spend on your paid work and the time you spend on other aspects of your life?



How much of the time do you find your job...

... interesting?



... stressful?



How likely would you say it is that you will become unemployed in the next 12 months?

- Very likely
 Likely
 Not very likely
 Not at all likely

To what extent do you agree or disagree with the following statement?

Considering all my efforts and achievements in my job, I feel I get paid appropriately.

- Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

How important is it for you to compare your income with other people's incomes?



Whose income would you be **most** likely to compare your own with?

- Work colleagues
 Family members
 Friends
 Others
 I don't compare

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Wellbeing survey – LSE

 39% complete

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Nature relatedness

 **Thanks—you've finished the section on wellbeing.** The remainder of the survey is about a wide range of other topics.

Please rate the extent to which you agree with each of these statements. There are no right or wrong answers.

I enjoy being outdoors, even in unpleasant weather

- Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

My ideal vacation spot would be a remote, wilderness area

- Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I always think about how my actions affect the environment

- Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I enjoy digging in the earth and getting dirt on my hands

- Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

My connection to nature and the environment is a part of my spirituality

- Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

disagree

I am very aware of environmental issues

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I take notice of wildlife wherever I am

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I don't often go out in nature

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I am not separate from nature, but a part of nature

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

The thought of being deep in the woods, away from civilization, is frightening

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

My feelings about nature do not affect how I live my life

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

Even in the middle of the city, I notice nature around me

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

My relationship to nature is an important part of who I am

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I think a lot about the suffering of animals

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

I feel very connected to all living things and the earth

Disagree strongly Disagree Neither agree nor disagree Agree Agree strongly

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Health and lifestyle

How is your health in general?

- Very good
 - Good
 - Fair
 - Bad
 - Very bad
-

Have you ever been told by a doctor that you have asthma?

- Yes
 - No
-

Have you ever been told by a doctor that you have a heart or lung disease?

- Yes
 - No
-

Do you ever smoke cigarettes?

- Yes
 - No
-

How many portions of fruit and vegetables do you usually eat a day?

Please do **not** count potatoes or grains.

Please **do** count pure juices, tinned, frozen and dried fruit and vegetables, and fruit and vegetables found in other foods.

- Fewer than 1 a day
 - 1 – 2 a day
 - 3 – 4 a day
 - 5 a day or more
-

And how often do you usually eat fish or shellfish?

Every day

- Several times a week
 - Once a week
 - Several times a month
 - Once a month
 - Less than once a month
 - Never
-

How much sleep did you get in the **past 24 hours**, to the nearest half hour?

Please select... 

How much sleep do you estimate that you **typically** get, per day?

Please select... 

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Health and lifestyle

How is your health in general?

- Very good
 - Good
 - Fair
 - Bad
 - Very bad
-

Have you ever been told by a doctor that you have asthma?

- Yes
 - No
-

Have you ever been told by a doctor that you have a heart or lung disease?

- Yes
 - No
-

Do you ever smoke cigarettes?

- Yes
 - No
-

How many cigarettes a day do you usually smoke, including those you roll yourself?

- Fewer than 1 a day
 - 1 – 5 a day
 - 5 – 14 a day
 - 15 – 24 a day
 - 25 a day or more
-

How many portions of fruit and vegetables do you usually eat a day?

Please do **not** count potatoes or grains.

Please **do** count pure juices, tinned, frozen and dried fruit and vegetables, and fruit and vegetables found in other

foods.

- Fewer than 1 a day
 - 1 – 2 a day
 - 3 – 4 a day
 - 5 a day or more
-

And how often do you usually eat fish or shellfish?

- Every day
 - Several times a week
 - Once a week
 - Several times a month
 - Once a month
 - Less than once a month
 - Never
-

How much sleep did you get in the **past 24 hours**, to the nearest half hour?

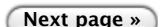


How much sleep do you estimate that you **typically** get, per day?



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Your home

You're over halfway through the survey. We really appreciate your help.

These questions are about the place where you usually live.

Is your household's accommodation...

- a house or bungalow
- a flat or maisonette
- a room (or rooms)
- or something else?

Which of these best describes your tenure here?

- Own outright
- Buying with the help of a mortgage or loan
- Rent
- Pay part rent and part mortgage (shared ownership)
- Live rent-free (excluding squatting)
- Squatting
- Other arrangement

How long have you lived in this accommodation?

- Less than 12 months
- 12 months but less than 2 years
- 2 years but less than 5 years
- 5 years but less than 10 years
- 10 years but less than 20 years
- 20 years or longer

And where did you live just before you moved to this accommodation?

- Greater London
- Another big city (population: over 1 million)
- A city or large town (population: 100,000 – 1 million)
- A town (population: 10,000 – 100,000)
- A village or hamlet (population: under 10,000)
- The countryside
- I've always lived in this accommodation

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Inside your home

 In this survey, a **household** means:

- one person living alone, or
- a group of people living at the same address who share common housekeeping or a living room.

How many adults (aged 16 or over) live in your household?

Please **include yourself** if you're aged 16 or over.

Please select... 

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And how many children (aged 15 or under) live in your household?

Please **include yourself** if you're aged 15 or under.

Please select... 

How many rooms does your household have the use of, not counting bathrooms and toilets?

Please select... 

On what floor of the building as a whole is your main living space?

If your main living space is on more than one floor, please choose the highest.

- Basement or semi-basement
- Ground floor (street level)
- 1st floor
- 2nd floor
- 3rd floor
- 4th – 9th floor
- 10th floor or higher

Do you have double glazing?

Please count only factory-made sealed units.



Yes—in all windows

- Yes—in some windows, but not all
- No—none

Does your home have any of the following problems?

Please tick **all** that apply.

- Mould growth (at least hand-sized patches) on walls or carpets
- Heating that doesn't keep you warm enough in winter
- Serious draughts due to poorly fitting windows or doors
- Insect infestation (e.g. moths, cockroaches, bedbugs or fleas)
- Lack of natural light
- None of the above

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Home postcode

We ask this question so we can work out environmental conditions—things such as levels of air pollution, noise, and distance to green spaces—around where you live.
Please be assured that your information is confidential and secure (click 'Help & information', above right, to find out more).

What is your full home postcode?

e.g. SW1A 1AA

I don't know my postcode

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Home postcode

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What is your full home postcode?

e.g. SW1A 1AA

I don't know my postcode

What are your street and city or town?

Please write **Street, City** (separated with a comma).

e.g. Downing Street, London

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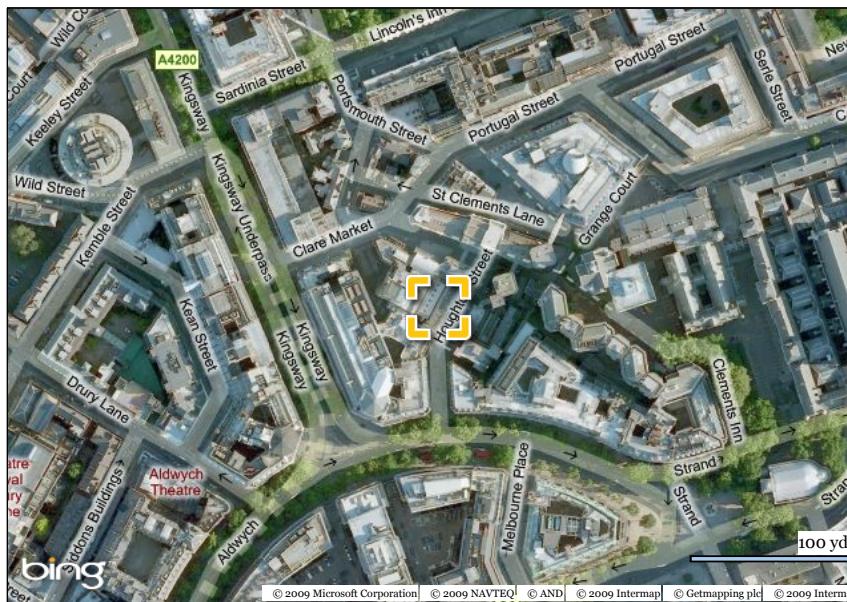
Your home on the map

We ask this question to help us work out environmental conditions as accurately as possible, since two buildings with the same postcode could be on different streets, with different levels of traffic, noise, and so on.

Please be assured that your information is confidential and secure (click 'Help & information', above right, to find out more).

Many thanks for providing your postcode. Based on this, the satellite map below should show the neighbourhood around your home.

Please click and drag to move the map so that your home is in the centre, inside the yellow box.



[Show help using the map »](#)

How did you get on?

- My home is in the yellow box
- My home is in or near the yellow box—it could be one or two buildings either way
- I couldn't find my home on the map
- The map didn't load/didn't work
- I prefer not to say exactly where I live

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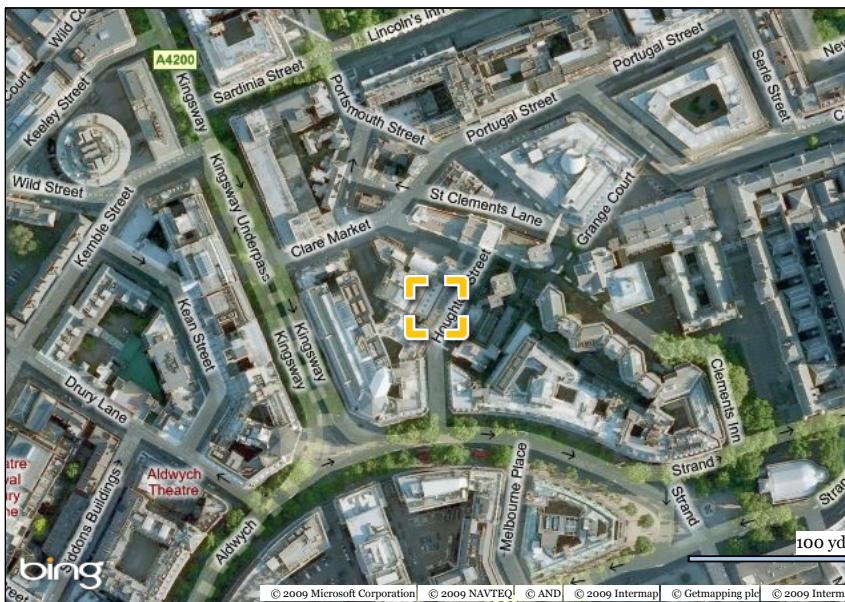
Your home on the map

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Many thanks for providing your postcode. Based on this, the satellite map below should show the neighbourhood around your home.

Please click and drag to move the map so that your home is in the centre, inside the yellow box.



 **Trouble finding your home?**

If you can't find your home on the map displayed here, please zoom out a few levels to get

 your bearings, then zoom back in on your home location.

Map controls

Zoom in: use the + button at the top left of the map, or double click on the point you wish to zoom in on.

Zoom out: use the - button at the top left of the map.

Move the map view: click on the map, keeping the mouse button held down; drag the map to a new location by moving your mouse; and release the mouse button.

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How did you get on?

- My home is in the yellow box
- My home is in or near the yellow box—it could be one or two buildings either way
- I couldn't find my home on the map
- The map didn't load/didn't work
- I prefer not to say exactly where I live

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Your neighbourhood

How satisfied are you with the area in which you live?



How safe do you — or would you — feel walking alone in this area after dark?

- Very safe
- Fairly safe
- A bit unsafe
- Very unsafe

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How often do you usually speak to your neighbours?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

Below are some things that can cause problems for people in their area. Which of these are problems in the area where you live?

Air pollution

- A serious problem
- A problem, but not serious
- Not a problem

Noise from road traffic and trains

- A serious problem
- A problem, but not serious
- Not a problem

Noise from aircraft

- A serious problem
- A problem, but not serious
- Not a problem

Noisy neighbours or loud parties

- A serious problem
- A problem, but not serious
- Not a problem

Rubbish or litter lying around

- A serious problem
- A problem, but not serious
- Not a problem

Vandalism or graffiti

- A serious problem
- A problem, but not serious
- Not a problem

Crime

- A serious problem
- A problem, but not serious
- Not a problem

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Green space

Do you have a garden?

- Yes—own garden
 - Yes—shared with others
 - No
-

Do you have an allotment?

- Yes
 - No
-

How well provided would you say your local area is with public parks, gardens, commons, and other public recreational green spaces?

Please consider the **number**, **size** and **quality** of these spaces.

243

- Very well
 - Well
 - Adequately
 - Poorly
 - Very poorly
-

During the summer, how often do you visit these kinds of green spaces for leisure?

Please **don't count** occasions when you only pass through on your way to somewhere else.

- Every day
 - Several times a week
 - Once a week
 - Several times a month
 - Once a month
 - Less than once a month
 - Never
-

And how often do you walk or cycle through these kinds of green spaces on your way to somewhere

else?

- Every day
 - Several times a week
 - Once a week
 - Several times a month
 - Once a month
 - Less than once a month
 - Never
-

During the summer, how often do you visit open countryside for leisure?

- Every day
 - Several times a week
 - Once a week
 - Several times a month
 - Once a month
 - Less than once a month
 - Never
-

Which of the following can you see from **any** of the windows in your home?

Please tick **all** that apply.

- Trees
 - Private recreational green space (e.g. gardens or allotments)
 - Public recreational green space (e.g. parks)
 - Other green space
 - None of the above
-

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Other location

Apart from your home, in what single location do you spend most time?

- Workplace
- Place of study
- Other location
- No single location

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Workplace postcode

We ask this question so we can work out environmental conditions—things such as levels of air pollution, noise, and distance to green spaces—around your workplace.

Please be assured that your information is confidential and secure (click 'Help & information', above right, to find out more).

What is the full postcode of your workplace?

e.g. SW1A 1AA

- I don't know the postcode

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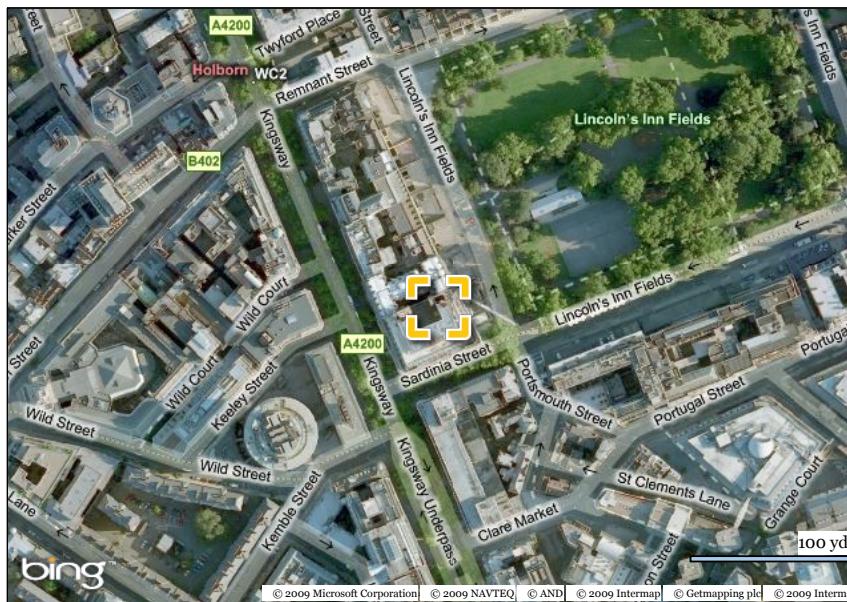
Your workplace on the map

 **We ask this question to help us work out environmental conditions as accurately as possible**, since two buildings with the same postcode could be on different streets, with different levels of traffic, noise, and so on.

Please be assured that your information is confidential and secure (click 'Help & information', above right, to find out more).

Many thanks for providing the postcode. Based on this, the satellite map below should show the neighbourhood around your workplace.

Please click and drag to move the map so that your workplace is in the centre, inside the yellow box.



Show help using the map »

How did you get on?

- My workplace is in the yellow box
- My workplace is in or near the yellow box—it could be one or two buildings either way
- I couldn't find my workplace on the map
- The map didn't load/didn't work
- I prefer not to say exactly where my workplace is

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Workplace details

About how much time does it usually take for you to get to your workplace each day, door to door?

- Less than 15 minutes
- 15 – 29 minutes
- 30 – 44 minutes
- 45 – 59 minutes
- An hour or more

Which of these means of transport do you usually use to travel to and from your workplace?

Please tick **all** that apply.

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- Train (above ground)
- Underground train (tube, metro)
- Bus, minibus or coach (public or private)
- Motorcycle, scooter or moped
- Driving a car or van
- Passenger in a car, van or taxi
- Bicycle
- Walking (or running) *for at least 5 minutes*
- None of the above

On what floor of the building as a whole do you spend most time in your workplace?

- Basement or semi-basement
- Ground floor (street level)
- 1st floor
- 2nd floor
- 3rd floor
- 4th – 9th floor
- 10th floor or higher
- No single floor

Which of the following can you usually see from inside your workplace?

Please tick **all** that apply.

- Trees
- Private recreational green space (e.g. gardens or allotments)
- Public recreational green space (e.g. parks)
- Other kinds of green space
- None of the above

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Leisure activities

In the past 12 months how often have you...

... read a newspaper?

Please **include** newspaper articles you read online.

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

... played sport, or done other vigorous physical exercise?

This could include going to the gym, taking exercise classes, running, cycling, skating or swimming.

247

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

... gone to a concert, theatre or other live performance?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

... visited historical monuments, museums, art galleries or archaeological sites?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

... practiced meditation?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

Please take a moment to think of any groups, clubs or organisations you take part in. These could be youth groups, sports clubs or pub teams, religious groups, evening classes, choirs, book groups, or any other groups, clubs or organisations.

In the past 12 months, how often did you take part in all groups, clubs or organisations like this combined?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

In the past 12 months, how often did you get involved in work for voluntary or charitable organisations?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

Not counting anything you do for your family, in your work, or within voluntary organisations, how often, in the past 12 months, did you actively provide help for other people?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

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And in the past 12 months, how often did you help with or attend activities organised in your local area?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

Is there a car or van normally available for private use by you or any members of your household?

- Yes—more than one
- Yes—one
- No—none

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SA-55

Wellbeing survey – LSE

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Demographics

What is your marital status?

Please choose the **first** option that applies. For all response options, please treat **Civil Partnership** as equivalent to marriage.

- Single (never married—but may be in a relationship)
- Married and living with your husband or wife
- Married and separated from your husband or wife
- Divorced
- Widowed

Do you have any children?

- Yes—more than one
- Yes—one
- No—none

What qualifications do you have?

These may be educational, professional, vocational or other work-related qualifications.

- Qualifications at degree level or above
- Qualifications below degree level
- No qualifications

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SA-56

Demographics

What is your marital status?

Please choose the **first** option that applies. For all response options, please treat **Civil Partnership** as equivalent to marriage.

- Single (never married—but may be in a relationship)
 - Married and living with your husband or wife
 - Married and separated from your husband or wife
 - Divorced
 - Widowed
-

And are you currently...

- living with someone as a couple, or
 - in a relationship with someone, but not living together, or
 - neither of the above?
-

249

Do you have any children?

- Yes—more than one
 - Yes—one
 - No—none
-

What are your children's ages?

Please tick **all** that apply.

- Under 2 years
 - 2 – 4
 - 5 – 10
 - 11 – 15
 - 16 – 20
 - 21 or over
-

What qualifications do you have?

These may be educational, professional, vocational or other work-related qualifications.

- Qualifications at degree level or above
- Qualifications below degree level
- No qualifications

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Work hours and activities

Excluding holidays, in the last 12 months how often have you worked more than 48 hours in a week?

- Every week
- Several times a month
- Once a month
- Less than once a month
- Never

Please tick all the statements that apply.

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In my work, I spend **at least half my time...**

- ... at a desk
- ... using a computer
- ... in the open air
- ... being physically active
- ... communicating face-to-face with others
- ... travelling
- None of the above

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Income

 **The wellbeing effect of income, relative to other factors, is an important part of our research**, so we would be very grateful for your answers here.

Please be assured that your information is confidential and secure (click 'Help & information', above right, to find out more).

Remember that in this survey a **household** means:

- one person living alone, or
- a group of people living at the same address who share common housekeeping or a living room.

What is your **household's** total gross annual income? This is:

- for all household members,
- from all sources (earnings, benefits, investments, etc.), and
- before taxes and National Insurance.

If you are not certain of an amount, please give your best estimate.



And what is your own **individual** total gross annual income? Again, this is:

- from all sources (earnings, benefits, investments, etc.), and
- before taxes and National Insurance.

If you are not certain of an amount, please give your best estimate.



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Religion and politics

Do you consider yourself as belonging to any particular religion or denomination?

- Yes
- No

Regardless of whether you belong to a particular religion, how religious would you say you are?



Apart from special occasions such as weddings and funerals, about how often do you attend religious services nowadays?

- 251
- Every day
 - More than once a week
 - Once a week
 - At least once a month
 - Only on special holy days
 - Less often
 - Never

How interested would you say you are in politics?



In politics people sometimes talk of “left” and “right”. Where would you place yourself on this scale?

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Your family background

These questions are about you and your family when you were growing up.

Do you have, or did you have, any **brothers**?

Please include adopted and half brothers.

- Yes—more than one
- Yes—one
- No—none

Do you have, or did you have, any **sisters**?

Please include adopted and half sisters.

- Yes—more than one
- Yes—one
- No—none

Did you live more or less continuously with **both** of your natural (birth) parents in the same home until you were 16?

If you lived with your natural parents except when away at a boarding school or for other temporary periods, please answer 'Yes'.

- Yes
- No
- Prefer not to answer

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Your family background

These questions are about you and your family when you were growing up.

Do you have, or did you have, any **brothers**?

Please include adopted and half brothers.

- Yes—more than one
- Yes—one
- No—none

Do you have, or did you have, any **sisters**?

Please include adopted and half sisters.

- Yes—more than one
- Yes—one
- No—none

Are you, or were you, the oldest, the youngest, or somewhere in between?

- Oldest
- Youngest
- In between

Did you live more or less continuously with **both** of your natural (birth) parents in the same home until you were 16?

If you lived with your natural parents except when away at a boarding school or for other temporary periods, please answer 'Yes'.

- Yes
- No
- Prefer not to answer

Why was this?

- There was a divorce or separation
-

- There was a death
- I was adopted
 - My parents never lived together
 - Another reason
 - Prefer not to answer

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Negative events

Have you suffered any of the following **in the last 3 years?**

Please tick **all** that apply.

- Compulsory redundancy
- Bankruptcy
- repossession of your home
- Death of a close friend or loved one
- Separation or divorce from your spouse
- Theft or fraud
- Violent or sexual crime
- None of the above

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SA-66

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Negative events

Have you suffered any of the following **in the last 3 years?**

Please tick **all** that apply.

- Compulsory redundancy
- Bankruptcy
- repossession of your home
- Death of a close friend or loved one
- Separation or divorce from your spouse
- Theft or fraud
- Violent or sexual crime
- None of the above

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If there's anything you'd like to add, please use this space.

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Pregnancy and menstrual cycle

 **We recognise that these are very personal questions, so please feel free not to answer them.** We ask them because we are interested in whether they have a measurable effect on day-to-day wellbeing.

As far as you're aware, are you pregnant?

- Yes
- No
- Prefer not to answer

Where are you currently in your menstrual cycle?

- I've got my period now
- My last period finished within the last 3 days
- I expect my next period to start within the next 3 days
- I'm at some other point in my cycle
- Not applicable
- Not sure
- Prefer not to answer

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Ethnicity

 **Almost finished.** To help ensure we survey a representative group of people, we'd be grateful if you'd answer this final, optional question.

To which of these ethnic groups do you consider you belong?

White

- White British
- Any other white background

Mixed

- White and Black Caribbean
- White and Black African
- White and Asian
- Any other mixed background

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Asian or Asian British

- Indian
- Pakistani
- Bangladeshi
- Any other Asian background

Black or Black British

- Caribbean
- African
- Any other Black background
- Chinese
- Any other ethnic group
- Prefer not to answer

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Finish and submit answers »

A.3.2 UK

Welcome



Thank you for your interest in this survey, which is:

- about your wellbeing ...
- ... and a wide range of other things that could affect it.
- 15 – 20 minutes long.
- anonymous and confidential.
- part of a research project at The London School of Economics (LSE).

Your completion of the survey represents your consent to serve as a subject in our research study. If you're under 18, please get consent from a parent or guardian before continuing.

 **Want to know more?** [See more details now](#), or click 'Help & information' at the top right of any page.

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What will I be asked?

The first third of the survey has questions about your general wellbeing and life satisfaction.

The remaining two thirds is about a wide range of other things that might be connected to your wellbeing. This part includes questions on: your home and local area, use of countryside and green spaces, exercise, basic demographics (age, sex, employment, income, etc.), religion, politics, family background, and a few others.

 **Got a question, concern, comment, or technical problem?**

Please don't hesitate to contact us.

- **Email:** g.j.mackerron@lse.ac.uk
- **Call:** 020 7106 1229 (ask for George)
- **Or Skype:** gmackerron—[text chat](#) or [call](#) (both are free of charge, but you must have Skype set up)

What will you do with my responses?

We're looking at people's wellbeing and how this may be connected to a wide range of different factors. Once everyone has completed the survey, we'll use various statistical methods to see what their combined responses can tell us about these relationships.

If you're curious to see what we find, please come back from time to time. We'll make our findings available here—<http://uk.wellbeingsurvey.org.uk>—as soon as they're ready. We also hope to present our findings in academic journals and conferences, and to make sure policy makers are aware of anything relevant.

In any case, we'll never show any individual's responses—only information at the group level.

Will you know who I am?

No. We don't ask for your name or contact information at any point. Some of the information we do ask for might in principle be used to help identify you, but we promise never to use it for this purpose, and we'll never disclose it to anyone else.

Who are you?

We're [George MacKerron](#) and [Dr Susana Mourato](#),
researchers in the [Department of Geography & Environment](#) at the [London School of Economics](#).



Department of Geography & Environment
London School of Economics
Houghton Street
London WC2A 2AE

Please [close this window or tab](#) to return to the survey.

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Are you male or female?

- Male
 Female

What is your age?

[Please select...](#)

What is your full home postcode?

e.g. SW1A 1AA

Which of these best describes your current situation?

- Self-employed
 In paid employment (full- or part-time)
 In full-time education
 Retired from paid work altogether
 Unemployed and seeking work
 On maternity leave
 On a government training scheme
 Looking after family or home
 Caring for a sick, elderly or disabled person
 Long term sick or disabled
 Something else

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All things considered, how satisfied are you with your life as a whole nowadays?

Extremely
dissatisfied



A horizontal scale with numbers 0 through 10. Each number has a radio button to its left. The radio button for '0' is filled, while others are empty.

Extremely
satisfied

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In general, would you say your health is...

- Excellent
- Very good
- Good
- Fair
- Poor

Compared to one year ago, how would you rate your health in general **now**?

- Much better now than one year ago
- Somewhat better now than one year ago
- About the same
- Somewhat worse now than one year ago
- Much worse now than one year ago

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The following items are about activities you might do during a typical day.

Does **your health now limit you** in these activities? If so, how much?

Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports

- Yes, limited a lot Yes, limited a little No, not limited at all

Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf

- Yes, limited a lot Yes, limited a little No, not limited at all

Lifting or carrying groceries

- Yes, limited a lot Yes, limited a little No, not limited at all

Climbing **several** flights of stairs

- Yes, limited a lot Yes, limited a little No, not limited at all

Climbing **one** flight of stairs

- Yes, limited a lot Yes, limited a little No, not limited at all

Bending, kneeling, or stooping

- Yes, limited a lot Yes, limited a little No, not limited at all

Walking more than a mile

- Yes, limited a lot Yes, limited a little No, not limited at all

Walking several blocks

- Yes, limited a lot Yes, limited a little No, not limited at all

Walking one block

- Yes, limited a lot Yes, limited a little No, not limited at all

Bathing or dressing yourself

- Yes, limited a lot Yes, limited a little No, not limited at all

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During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health?**

Cut down the amount of time you spent on work or other activities

- Yes
- No

Accomplished less than you would like

- Yes
- No

Were limited in the **kind** of work or other activities

- Yes
- No

Had **difficulty** performing the work or other activities (for example, it took extra effort)

- Yes
- No

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During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

Cut down the **amount of time** you spent on work or other activities

- Yes
- No

Accomplished less than you would like

- Yes
- No

Didn't do work or other activities as carefully as usual

- Yes
- No

During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

- Not at all
- Slightly
- Moderately
- Quite a bit
- Extremely

How much **bodily** pain have you had during the **past 4 weeks**?

- None
- Very mild
- Mild
- Moderate
- Severe
- Very severe

During the **past 4 weeks**, how much did **pain** interfere with your normal work (including both work outside the home and housework)?

- Not at all
- A little bit
- Moderately
- Quite a bit
- Extremely

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These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the **past 4 weeks**...

Did you feel full of enthusiasm?

<input type="radio"/>	All of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	A good bit of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	A little of the time	<input type="radio"/>	None of the time
-----------------------	-----------------	-----------------------	------------------	-----------------------	------------------------	-----------------------	------------------	-----------------------	----------------------	-----------------------	------------------

Have you been a very nervous person?

<input type="radio"/>	All of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	A good bit of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	A little of the time	<input type="radio"/>	None of the time
-----------------------	-----------------	-----------------------	------------------	-----------------------	------------------------	-----------------------	------------------	-----------------------	----------------------	-----------------------	------------------

Have you felt so down in the dumps that nothing could cheer you up?

<input type="radio"/>	All of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	A good bit of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	A little of the time	<input type="radio"/>	None of the time
-----------------------	-----------------	-----------------------	------------------	-----------------------	------------------------	-----------------------	------------------	-----------------------	----------------------	-----------------------	------------------

Have you felt calm and peaceful?

<input type="radio"/>	All of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	A good bit of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	A little of the time	<input type="radio"/>	None of the time
-----------------------	-----------------	-----------------------	------------------	-----------------------	------------------------	-----------------------	------------------	-----------------------	----------------------	-----------------------	------------------

Did you have a lot of energy?

<input type="radio"/>	All of the time	<input type="radio"/>	Most of the time	<input type="radio"/>	A good bit of the time	<input type="radio"/>	Some of the time	<input type="radio"/>	A little of the time	<input type="radio"/>	None of the time
-----------------------	-----------------	-----------------------	------------------	-----------------------	------------------------	-----------------------	------------------	-----------------------	----------------------	-----------------------	------------------

Have you felt downhearted and blue?

auto-scroll is on

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

Did you feel worn out?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

Have you been a happy person?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

Did you feel tired?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

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During the **past 4 weeks**, how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?

<input type="radio"/>				
All of the time	Most of the time	Some of the time	A little of the time	None of the time

How **true** or **false** is each of the following statements for you?

I seem to get sick a little easier than other people

<input type="radio"/>				
Definitely true	Mostly true	Don't know	Mostly false	Definitely false

I am as healthy as anybody I know

<input type="radio"/>				
Definitely true	Mostly true	Don't know	Mostly false	Definitely false

I expect my health to get worse

<input type="radio"/>				
Definitely true	Mostly true	Don't know	Mostly false	Definitely false

My health is excellent

<input type="radio"/>				
Definitely true	Mostly true	Don't know	Mostly false	Definitely false

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Here are a number of words that describe different feelings and emotions.

For each item, please indicate to what extent you have felt this way **during the past few weeks**.

Interested

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Distressed

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Excited

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Upset

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Strong

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Guilty

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<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Scared

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Hostile

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Enthusiastic

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Proud

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Irritable

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Alert

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Ashamed

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<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Very slightly or not at all A little Moderately Quite a bit Extremely

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Inspired

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Very slightly or not at all A little Moderately Quite a bit Extremely

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Nervous

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

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Determined

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

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Attentive

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Jittery

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Active

<input type="radio"/>				
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

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Have you ever been told by a doctor that you have asthma?

- Yes
 No

Have you ever been told by a doctor that you have a heart or lung disease (other than asthma)?

- Yes
 No

Do you ever smoke cigarettes?

- Yes
 No

How many portions of fruit and vegetables do you usually eat a day?

Please do **not** count potatoes or grains.
Please **do** count pure juices, tinned, frozen and dried fruit and vegetables, and fruit and vegetables found in other foods.

- Fewer than 1 a day
 1 – 2 a day
 3 – 4 a day
 5 a day or more

How much sleep did you get in the **past 24 hours**, to the nearest half hour?

Please select...

How much sleep do you estimate that you **typically** get, per day?

Please select...

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 You're over one third of the way through the survey. We really appreciate your help.

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These questions are about the place where you usually live.

Is your household's accommodation...

- a house or bungalow
- a flat or maisonette
- a room (or rooms)
- or something else?

Which of these best describes your tenure here?

- Own outright
- Buying with the help of a mortgage or loan
- Rent
- Pay part rent and part mortgage (shared ownership)
- Live rent-free (excluding squatting)
- Squatting
- Other arrangement

How long have you lived in this accommodation?

- Less than 12 months
- At least 12 months but less than 2 years
- At least 2 years but less than 5 years
- At least 5 years but less than 10 years
- At least 10 years but less than 20 years
- 20 years or longer

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 In this survey, a **household** means:

- one person living alone, or
- a group of people living at the same address who share common housekeeping or a living room.

How many adults (aged 16 or over) live in your household?

Please include yourself.

[Please select...](#) 

And how many children (aged 15 or under) live in your household?

[Please select...](#) 

How many rooms does your household have the use of, not counting bathrooms and toilets?

[Please select...](#) 

On what floor of the building as a whole is your main living space?

If your main living space is on more than one floor, please choose the highest.

- Basement or semi-basement
- Ground floor (street level)
- 1st floor
- 2nd floor
- 3rd floor
- 4th – 9th floor
- 10th floor or higher

Do you have double glazing?

Please count only factory-made sealed units.

- Yes—in all windows
- Yes—in some windows, but not all

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No—none

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Does your home have any of the following problems?

Please tick **all** that apply.

- Mould growth (at least hand-sized patches) on walls or carpets
- Heating that doesn't keep you warm enough in winter
- Serious draughts due to poorly fitting windows or doors
- Insect infestation (e.g. moths, cockroaches, bedbugs or fleas)
- Lack of natural light
- None of the above

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How satisfied are you with the area in which you live?

Extremely dissatisfied	Extremely satisfied
<input type="radio"/>	<input type="radio"/>
0	10

How safe do you – or would you – feel walking alone in this area after dark?

- Very safe
- Fairly safe
- A bit unsafe
- Very unsafe

How often do you usually speak to your neighbours?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

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Below are some things that can cause problems for people in their area. Which of these are problems in the area where you live?

Air pollution

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

Noise from road traffic and trains

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

Noise from aircraft

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

Noisy neighbours or loud parties

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

Rubbish or litter lying around

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

Vandalism or graffiti

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

Crime

<input type="radio"/> A serious problem	<input type="radio"/> A problem, but not serious	<input type="radio"/> Not a problem
---	--	-------------------------------------

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Which of the following can you see from any of the windows in your home?

Please tick **all** that apply

- Green space, lawns
- Trees
- The sea
- Rivers or lakes
- Ponds or water features
- Bird boxes or feeders
- None of these

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Do you have a garden?

- Yes—own garden
- Yes—shared with others
- No

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Are you currently a member of any conservation, nature or wildlife organisations?

Please tick **all** that apply

- RSPB (the Royal Society for the Protection of Birds)
- National Trust
or National Trust for Scotland
- Campaign to Protect Rural England *or* Wales
or Association for the Protection of Rural Scotland
- Woodland Trust
- Wildfowl & Wetland Trust
- Other organisation(s)
- None of these

Do you intend to leave a legacy to any conservation, nature or wildlife organisations in your Will?

- Definitely
- Probably
- Probably not
- Definitely not
- Don't know

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In the **past 3 months**, approximately how many times have you spent any time in countryside, coastal sites or gardens **owned by the National Trust?**

Please **include** visits to National Trust properties that comprise a house and gardens where you spent some time visiting the gardens.

- None
- Once or twice
- 3 – 5 times
- 6 – 11 times
- 12 times or more

In the **past 3 months**, approximately how many times have you spent any time in an RSPB reserve?

The RSPB is the Royal Society for the Protection of Birds.

- None
- Once or twice
- 3 – 5 times
- 6 – 11 times
- 12 times or more

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The UK has 15 National Parks:

- Brecon Beacons
- Broads
- Cairngorms
- Dartmoor
- Exmoor
- Lake District
- Loch Lomond
- New Forest
- Northumberland
- North York Moors
- Peak District
- Pembrokeshire Coast
- Snowdonia
- South Downs
- Yorkshire Dales



In the **past 3 months**, approximately how many times have you spent any time in a UK National Park?

i **It's no problem if visits you include on this page overlap with those on the previous page.**

For example, if you've visited National Trust gardens within a National Park, please include those visits in both totals.

- I live in a National Park
- None
- Once or twice
- 3 – 5 times
- 6 – 11 times
- 12 times or more

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In the **past 3 months**, have you ...

... done any birdwatching?

- Yes, regularly
- Yes, occasionally
- No

... taken photos of nature/wildlife in natural habitats?

- Yes, regularly
- Yes, occasionally
- No

... spent any time drawing, painting or sculpting representations of nature/wildlife in natural habitats?

- Yes, regularly
- Yes, occasionally
- No

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Over the **past 3 months**, how often have you typically spent any time in your **own garden**?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

Over the **past 3 months**, approximately how much money would you say you spent on garden products such as plants, trees and seeds, bird boxes and bird feed, and pond plants, fish or fish food?

- No money
- £24 or less
- £25 – £49
- £50 – £99
- £100 – £249
- £250 – £499
- £500 or more
- Don't know

273

Over the **past 3 months**, how often have you typically spent any time in **cemeteries or church gardens**?

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

Over the **past 3 months**, how often have you typically spent any time in **open countryside or farmland**?

Please **include** any visits to National Trust countryside, and to countryside within National Parks and RSPB reserves, mentioned in earlier questions.

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

Over the **past 3 months**, how often have you spent any time in **any other green spaces** (not listed above)?

These could include urban parks, recreation grounds, village greens, golf courses, and others.

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

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Thinking about the time you spend in the **open countryside**, which of these habitat types would you say you **spend most time in?**

Please tick **up to 5**.

- Coastal: saltmarsh, sand dunes, vegetated shingle, cliffs and slopes
- Freshwater: rivers, lakes, ponds, reservoirs
- Woodland: woods and forests
- Grassland: meadows, pastures, grazing land
- Heathland: with dwarf shrubs such as heather and gorse
- Wetland: marshes, fens, bogs and reedbeds
- Upland: hilly and mountainous areas
- Farmland: land planted with crops

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In the **past 12 months**, approximately how many times have you attended nature/wildlife photography exhibitions?

- None
- Once or twice
- 3 – 5 times
- 6 – 11 times
- 12 times or more

Do you subscribe to or regularly buy any nature/wildlife magazines?

This could be BBC Wildlife magazine, National Geographic and so on.

- Yes
- No

How often would you say you watch any nature/wildlife programmes?

This could be on broadcast TV, Sky, iPlayer, DVD and so on.

- Every day
- Several times a week
- Once a week
- Several times a month
- Once a month
- Less than once a month
- Never

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In the **past 12 months**, approximately how much time in total have you spent watching BBC TV programmes featuring **nature/wildlife in the UK** (such as Springwatch, Autumnwatch, Coast, Wild Wales, and so on)?

These could have been on broadcast TV, iPlayer or DVD.

- No time
- Up to 6 hours (30 mins per month)
- Up to 12 hours (1 hour per month)
- Up to 24 hours (2 hours per month)
- Up to 36 hours (3 hours per month)
- Up to 48 hours (4 hours per month)
- More than 48 hours
- Don't know

How much would you be willing to pay as part of your current BBC licence fee for such programmes to be made?

275

- Nothing
- £0.99 or less
- £1.00 – £1.99
- £2.00 – £4.99
- £5.00 – £9.99
- £10.00 – £19.99
- £20.00 – £49.99
- £50.00 – £74.99
- £75.00 – £99.99
- £100.00 or more
- Don't know

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The next few pages will ask about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person.

Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

 Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**.

- **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.
- **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

Do you currently have a job or do any unpaid work outside your home?

276

This **includes** paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. **Do not include** unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family.

- Yes
 No

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The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include travelling to and from work.

During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No vigorous job-related activity

How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week

- 5 days per week
- 6 days per week
- 7 days per week
- No moderate job-related activity

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How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No job-related walking

277

How much time did you usually spend on one of those days **walking** as part of your work?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

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These questions are about how you traveled from place to place, including to places like work, shops, movies, and so on.

During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car or tram?

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No travelling in a motor vehicle

278

How much time did you usually spend on one of those days **travelling** in a train, bus, car, tram, or other kind of motor vehicle?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

Now think only about the **bicycling and walking** you might have done to travel to and from work, to do errands, or to go from place to place.

During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

- 1 day per week
- 2 days per week
- 3 days per week

- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No bicycling from place to place

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How much time did you usually spend on one of those days to bicycle from place to place?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No walking from place to place

How much time did you usually spend on one of those days **walking** from place to place?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

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This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard?**

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No vigorous activity in garden or yard

How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard?**

- 1 day per week
- 2 days per week
- 3 days per week

- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No moderate activity in garden or yard

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- 6 hours or more

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How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

280

Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No moderate activity inside home

How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours


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This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure.

 Please do not include any activities you have already mentioned.

Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you walk for at least 10 minutes at a time **in your leisure time**?

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No walking in leisure time

281

How much time did you usually spend on one of those days **walking** in your leisure time?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

And for how much of this time you spent walking in your leisure time were you out **in the countryside or other green spaces**?

- All of this time
- Most of this time
- Some of this time
- A little of this time

None of this time

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Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No vigorous activity in leisure time

How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

And for how much of this time you spent doing vigorous activity in your leisure time were you out **in the countryside or other green spaces**?

- All of this time
- Most of this time
- Some of this time
- A little of this time
- None of this time

Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in your **leisure time**?

- 1 day per week
- 2 days per week
- 3 days per week
- 4 days per week
- 5 days per week
- 6 days per week
- 7 days per week
- No moderate activity in leisure time

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How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

282

And for how much of this time you spent doing moderate physical activites in your leisure time were you out **in the countryside or other green spaces?**

- All of this time
- Most of this time
- Some of this time
- A little of this time
- None of this time

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SB-51

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These questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

 Do not include any time spent sitting in a motor vehicle that you have already mentioned.

During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

- Less than 30 minutes
- 30 minutes but less than 60 minutes
- 60 minutes but less than 90 minutes
- 90 minutes but less than 2 hours
- 2 hours but less than 4 hours
- 4 hours but less than 6 hours
- 6 hours or more

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SB-52

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Apart from your home, in what single location do you spend most time?

- Workplace
- Place of study
- Other location
- No single location

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What is the full postcode of your workplace?

About how much time does it usually take for you to get to your workplace each day, door to door?

- Less than 15 minutes
- 15 – 29 minutes
- 30 – 44 minutes
- 45 – 59 minutes
- An hour or more

Which of these means of transport do you usually use to travel to and from your workplace?

Please tick **all** that apply.

- Train (above ground)
- Underground train (tube, metro)
- Bus, minibus or coach (public or private)
- Motorcycle, scooter or moped
- Driving a car or van
- Passenger in a car, van or taxi
- Bicycle
- Walking (or running) *for at least 5 minutes*
- None of the above

On what floor of the building as a whole do you spend most time in your workplace?

- Basement or semi-basement
- Ground floor (street level)
- 1st floor
- 2nd floor
- 3rd floor
-

4th – 9th floor

- 10th floor or higher
- No single floor

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Which of the following can you usually see from inside your workplace?

Please tick **all** that apply.

- Green space, lawns
- Trees
- The sea
- Rivers or lakes
- Ponds or water features
- Bird boxes or feeders
- None of these

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Please take a moment to think of any groups, clubs or organisations you take part in. These could be youth groups, sports clubs or pub teams, religious groups, evening classes, choirs, book groups, or any other groups, clubs or organisations.

In the past 12 months, how often did you take part in all groups, clubs or organisations like this combined?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

In the past 12 months, how often did you get involved in work for voluntary or charitable organisations?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

And in the past 12 months, how often did you help with or attend activities organised in your local area?

- At least once a week
- At least once a month
- At least once every three months
- At least once every six months
- Less often
- Never

Is there a car or van normally available for use by you or any members of your household?

- Yes—a privately owned car or van
- Yes—a car club car or van
- No

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What is your marital status?

Please choose the **first** option that applies. For all response options, please treat **Civil Partnership** as equivalent to marriage.

- Single (never married—but may be in a relationship)
- Married and living with your husband or wife
- Married and separated from your husband or wife
- Divorced
- Widowed

Do you have any children?

- Yes—more than one
- Yes—one
- No—none

What qualifications do you have?

These may be educational, professional, vocational or other work-related qualifications.

- Qualifications at degree level or above
- Qualifications below degree level
- No qualifications

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SB-57

SB-58

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These questions are about you and your family when you were growing up.

Do you have, or did you have, any **brothers or sisters?**

Please include adopted and half brothers and sisters.

- Yes—more than one
- Yes—one
- No—none

Did you live more or less continuously with **both** of your natural (birth) parents in the same home until you were 16?

If you lived with your natural parents except when away at a boarding school or for other temporary periods, please answer 'Yes'.

- Yes
- No
- Prefer not to answer

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Have you suffered any of the following **in the last year?**

Please tick **all** that apply.

- Compulsory redundancy
- Bankruptcy
- Repossession of your home
- Death of a loved one
- Separation or divorce from your spouse
- Theft or fraud
- Violent crime
- None of the above

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Thank you

Many thanks for taking the time to complete this survey. We hope you found it interesting.

Find out more

Results from our study will be posted here—<http://uk.wellbeingsurvey.org.uk/>—as soon as they're available.

In the meantime, you can find out more about wellbeing and wellbeing research from these sources, amongst others:

- [Centre for Confidence and Wellbeing](#)
- [New Economics Foundation](#)
- [Foresight Programme of the UK Government](#)

Questions or comments?

If you have any questions or comments, please contact us:

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A.4 The *websperiment* framework



The paper reproduced below is published in the Journal of Choice Modelling (MacKerron, 2011b).

Implementation, implementation, implementation: old and new options for putting surveys and experiments online

George MacKerron

Department of Geography & Environment,
London School of Economics & Political Science, United Kingdom

Abstract

The Internet offers enormous possibilities for surveys and experimental data collection, including randomised treatments, customisation, and interactivity. These capabilities are well suited to the implementation of choice modelling experiments.

However, the implementation of web surveys is not a simple task, and the existing options open to researchers are commonly unsatisfactory in a number of ways. The result is that few Internet surveys and experiments are able to exploit the unique capabilities of the web.

This paper suggests a new approach, illustrated with a working prototype: an open-source, domain-specific language (DSL) designed for specifying web surveys and experiments, which is called *websperiment*.

The paper first looks at the existing approaches, highlighting their strengths and weaknesses. It then outlines the concepts underlying *websperiment*, and this DSL's nature and scope, with simple code examples. Finally, it shows how the DSL can be used to concisely specify a highly dynamic choice modelling survey.

1 Introduction

The Internet offers enormous possibilities for survey and experimental data collection: randomisation, customisation, interactivity, paradata¹, and more. Web surveying is cheaper and faster than traditional approaches, and as universal Internet access edges ever closer, its biggest single drawback—an incomplete and biased sampling frame—is set to keep on diminishing.

There has, rightly, been much interest in mode effects and in the sampling, validity, and design issues associated with web surveys (e.g. Marta-Pedroso et al., 2007; Dillman et al., 1998; Schonlau et al., 2002; Couper, 2008). There has, however, been rather little discussion regarding the practical implementation of such surveys.

Survey implementation matters, and it matters arguably even more on the web than in some other modes: an online instrument must compensate for the lack of trained interviewers to administer it. Web survey implementation affects accessibility, compatibility and consistency across respondents;

¹Paradata are data that "do not describe the respondent's answers but the process of answering the web questionnaire" (Heerwagh, 2003), for example, the time a respondent spends answering a specific question, or the sequence in which response options are chosen.

it affects respondent motivation and experience; it creates context effects, and has implications for data security.

Implementation is a genuinely difficult problem. It is subject to the combined challenges both of good generic survey implementation and of good generic web application implementation². It is a problem which increases in scale in tandem with the potential rewards: “the more complexity one builds into the instrument, the greater the cost and effort required to program and test the survey, and the greater the likelihood that something might not work as intended” Couper (2008, 30).

Implementation is arguably a problem which has yet to be satisfactorily addressed. Few Internet surveys currently exploit the unique capabilities of the web: most function simply as on-screen representations of a paper-and-pencil design. Furthermore, even such unambitious representations are rarely executed well. Couper (2008, xvi) appears justified in his continuing amazement “at the poor design of many web surveys”.

In the hope of helping to improve web survey implementation, this paper suggests a new approach, embodied in and illustrated by a working prototype. The approach has three distinctive aspects. First, it involves the development of a ‘domain-specific’ programming language (DSL). Second, it makes liberal use of a mechanism known as ‘inheritance’, an important element in object-oriented programming. Finally, it is open source. These are somewhat technical concepts, and *prior knowledge is not assumed*. They are considered in more detail in section 3.

The rest of the paper is structured as follows: section 2 looks at the main options currently available to researchers implementing web surveys, and their advantages and limitations; section 3 describes the DSL approach; section 4 illustrates the potential for its application to a web-based choice experiment; and section 5 concludes.

2 Existing survey implementation options

Researchers trying to implement a survey or experiment online generally choose one of four major options: a managed web-based service; a locally-installed software application; a specialist consultancy; or some form of Do-It-Yourself (that is: pick a programming language, and start writing code).

(a) Managed web-based service

These services enable a survey to be designed via a web-based Graphical User Interface (GUI), and then hosted on the provider’s server. Popular web-based services include: SurveyMonkey, QuestionPro, Zoomerang and Wufoo, which are principally business-focused; Bristol Online Surveys, which has a more academic flavour; and various offerings from Qualtrics, which aims more specifically at market research professionals. Typically a web-based service is a relatively low-cost option offering rather basic features. Often it also produces an unattractive and poorly accessible survey (Kuipers, 2005).³

²The latter include not only the general challenges associated with IT service development, in which effective communication of requirements is a key factor, but a further host of technical characteristics related to the web. For example: respondents must be tracked across separate page requests, overcoming the statelessness of the underlying protocol, HTTP; limited, inconsistent and incompatible browser, operating system and hardware capabilities and settings must all be accommodated; logic must be split or duplicated between the server and untrusted clients; and in spite of all this, an attractive, consistent and easily navigated user interface must be maintained.

³For example, the popular service SurveyMonkey uses non-standard custom form controls (check-boxes, radio buttons and so on). These controls are unfamiliar to web users, and raise accessibility issues both in terms of disabled users (screen reading software will not recognise them) and web browser configuration (respondents without JavaScript enabled,

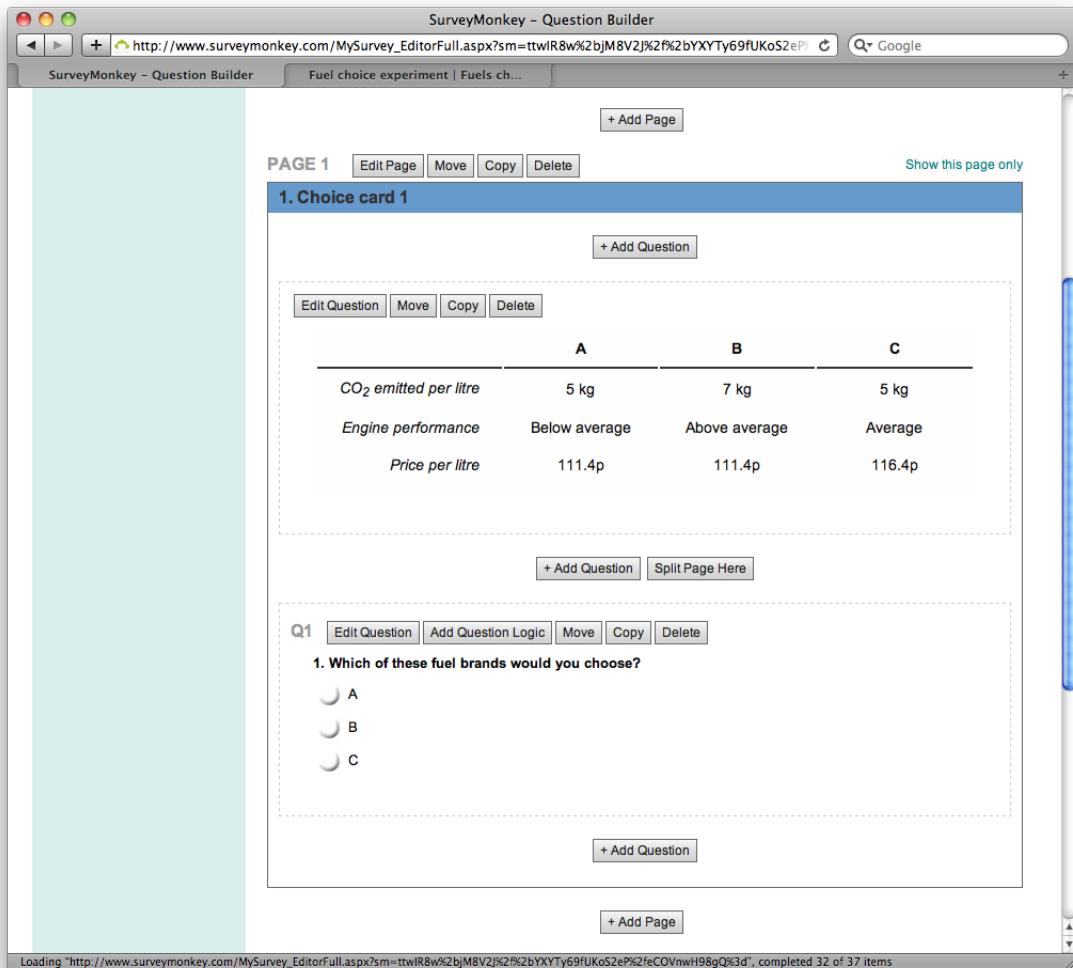


Figure 1: Creating a basic choice card, using an image for the choice presentation, using SurveyMonkey.

It is possible to implement a choice experiment with these services via the traditional pen-and-paper strategy of creating multiple versions of the survey instrument, differing only in the attribute levels displayed within the choice cards section (this can be coupled with a simple server-side script which redirects visitors to one of the multiple survey versions at random). Depending on the capabilities of the service used, formatted items such as tables may have to be inserted as images, and in this case the information will not be accessible to screen-reader software.

Figures 1 and 2 illustrate the use of SurveyMonkey to design a choice card, and the resulting survey display.

(b) Locally-installed software application

The boundaries between web-based services and locally-installed software are increasingly becoming blurred, but locally-installed software generally provides a more advanced feature set than the web-based services discussed above. Like web-based services, locally-installed software generally offers a comprehensive GUI for survey design. GUIs should facilitate discovery of the

including many who are subject to institutional IT security policies, see only the message “JavaScript is required for this site to function, please enable”). Bristol Online Surveys, to which many UK academic institutions subscribe, provides no routing capabilities and does not use the HTML <label> tag for form controls (this is disability-unfriendly, and also makes the controls an inconveniently small click target). Some other services provide no ‘previous page’ control (and break when the browser’s ‘back’ button is used), require Java or Adobe Flash, or exclude non-Windows users.

[SURVEY PREVIEW MODE] Fuel choice survey

Fuel choice survey

1. Choice card 1

	A	B	C
<i>CO₂ emitted per litre</i>	5 kg	7 kg	5 kg
<i>Engine performance</i>	Below average	Above average	Average
<i>Price per litre</i>	111.4p	111.4p	116.4p

1. Which of these fuel brands would you choose?

A
 B
 C

Next

Figure 2: Choice card page designed and hosted using SurveyMonkey.

software's features and eliminate some kinds of input error. Survey design GUIs may be somewhat clumsy, however, with option-heavy dialogue-boxes nested many levels deep (see The Survey System software illustrated in Figure 3, for example).

Locally-installed survey software may be expensive, particularly if the cost cannot be spread across multiple projects, and is generally subject to restrictive licencing terms regarding who may install and use it, on what scale, and for how long. Once a survey is designed, arrangements must then be made for hosting online. Most software providers offer paid hosting options, and/or enable the export of scripting files and supporting resources for hosting on your own server. The latter option will generally require particular server features, such as the availability of a scripting language (e.g. Perl) or the use of a particular platform (e.g. Microsoft Windows with Internet Information Services (IIS) server software).

Some software is designed specifically for the implementation of online choice experiments, and can automatically generate a range of experimental designs based on the attributes and levels specified—an extremely useful capability. Figures 4 and 5 show the design and display of a choice experiment using one such software package, SSI Web.

(c) Specialist consultancy

The results of engaging consultants ultimately depend, obviously, on the skills and experience of the consultants. However, a consultancy itself may well be using one of the options discussed above, in which case the service offered will be subject to the same strengths and limitations. Achieving precise communication of requirements is likely to be a significant challenge, and some level of control will be lost. This option is also liable to be expensive.

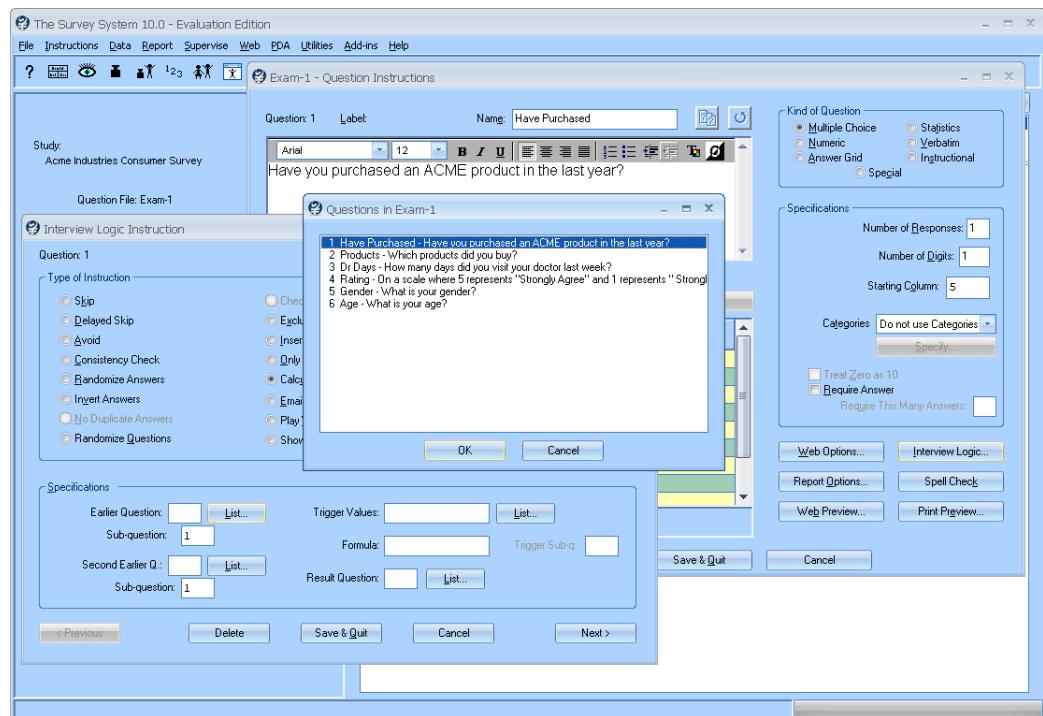


Figure 3: Widget overload: The Survey System software

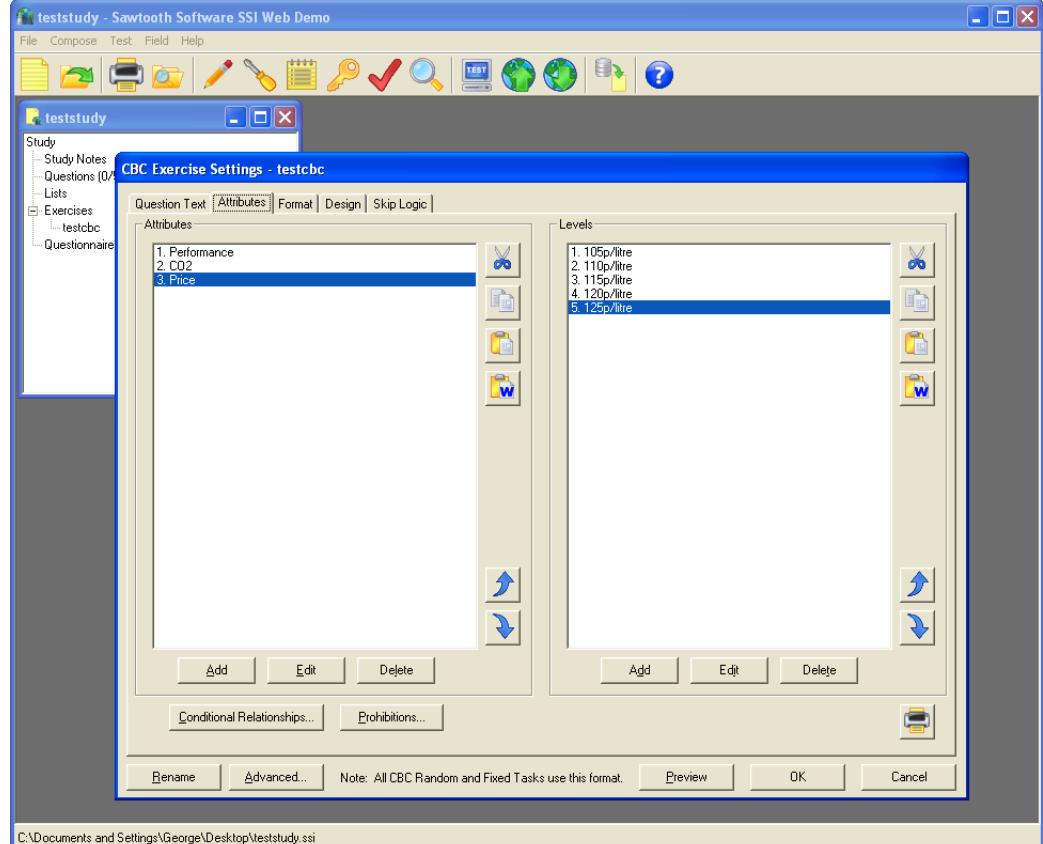


Figure 4: SSI Web attribute/level specification dialogue

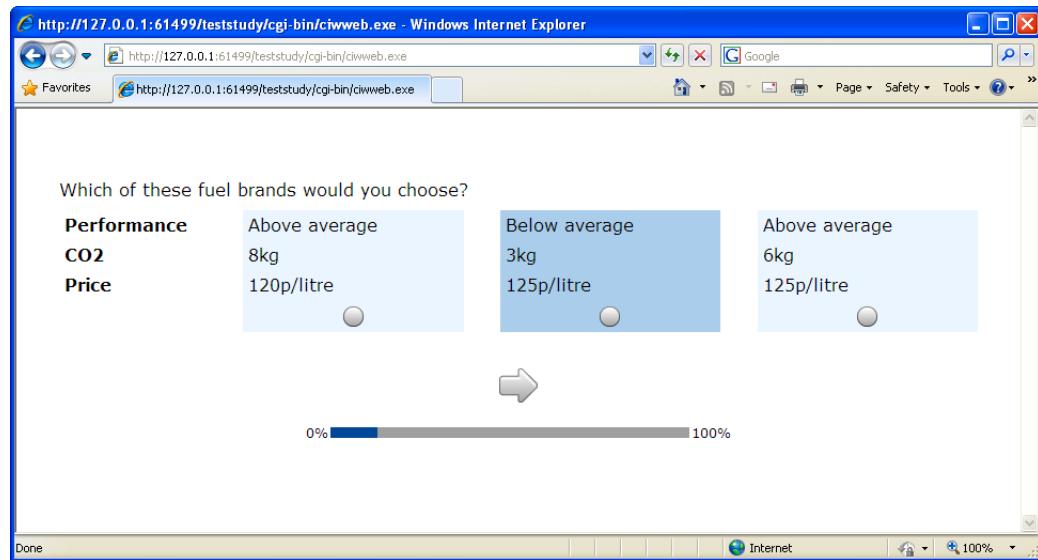


Figure 5: Choice card page produced by SSI Web

(d) Do-It-Yourself development

Creating a web survey using nothing more than a general purpose programming language allows complete control and flexibility, and is an option that has been advocated elsewhere (e.g. Fraley, 2004). To do a good job, however, one needs (or needs access to) user interface expertise, visual design and programming skills, and web design experience. Even assuming all these things are available, having researchers everywhere re-implement basic web survey features—and even generic web application features—represents an extraordinary duplication of effort. It is also liable to result in little-tested and therefore buggy software, and to prove costly in time and salaries.

2.1 General limitations

None of the available options make it easy for researchers to share survey items or item types, or build on such work shared by others (in the way, say, that researchers can share their own work and make use of others' in the form of new routines or libraries for statistical software packages). Nor do these options typically make it easy to describe the underlying mechanics of a survey, either for communicating with co-authors or for reporting research methods externally (for example: What is the page-to-page skip logic? How are dynamic response options calculated? Which options are shown in randomised order?).⁴

⁴Options (a) – (c) above generally keep the workings of a survey either entirely opaque or spread throughout a series of GUI locations, while option (d) will likely produce code that is verbose and complex, where the house-keeping noise of saving data, specifying layout and so on overwhelms the details relevant to survey specification.

3 A new approach

The new approach suggested here is the use of a domain-specific language (DSL).⁵ This DSL approach is related to the Do-It-Yourself development option in the discussion above, and retains its total flexibility. However, it addresses both major drawbacks of that option: first, the need for extensive expertise in web design; and second, the need to re-implement basic web application and web survey features from scratch.

3.1 A domain-specific language...

DSLs are programming languages designed to address a particular, limited problem space (as opposed to the general-purpose languages, such as C, Java, Perl and Python, in which most computer software is written). Many researchers will be familiar with one or more DSLs already. For example, in statistical packages that provide a syntax for describing and combining operations—including R, Stata, Limdep/NLOGIT, and SPSS—this syntax is well described as a DSL.

Other popular examples are LATEX (for document typesetting/formatting), PostScript (page layout), SQL (querying and managing databases), CSS (web page formatting), Regular Expressions (text processing), XSLT (transforming XML documents) and the configuration files of the Apache web server and many other Unix tools.

3.1.1 What do DSLs do?

DSLs are designed to reflect the structure and content of the problem domain, making it straightforward to create and connect common items, actions and rules to form larger systems. As Sprinkle et al. (2009, 16) explain:

Ideally, a DSL follows the domain abstractions and semantics as closely as possible, letting developers perceive themselves as working directly with domain concepts. The created specifications might then represent simultaneously the design, implementation, and documentation of the system...

A distinction is sometimes drawn between internal (or embedded) and external (or standalone) DSLs (Fowler, 2009). An external DSL has its own syntax, parser, and unique set of capabilities. An internal DSL, meanwhile, is a framework that extends an existing general purpose language. Some general purpose languages are more suited to hosting internal DSLs than others: key factors include the suitability of the syntax and the presence of 'meta-programming' features that make the language easy to extend.

Internal DSLs have several benefits. They are easy to implement. They get the capacities of their host language, including its existing function libraries, completely free. For those who know the host language, they use a familiar syntax; and for those that do not, they offer an easy way in to learning it.

⁵A DSL for surveys is not truly novel: there is one existing example, Topsl, described by MacHenry & Matthews (2004). Topsl's aims, capabilities and implementation are very different, however. First, Topsl requires surveys to be amenable to static analysis, so that the same source can either be displayed as web pages or formatted for printing. While this is undoubtedly useful if a hard copy is required, it removes at one stroke most of the power gained by moving surveys online. Second, Topsl is implemented in the programming language Scheme, a dialect of Lisp. Scheme is elegant, minimalist, and well suited to DSLs. However, it is also littered with parentheses and highly unlike natural language, making it rather difficult to understand (or indeed write) the survey code. Finally, Topsl includes a bare minimum of features and is not a realistic option for presenting real surveys.

3.1.2 Who are DSLs for?

DSLs are still essentially programming languages. They are picky about punctuation, capital letters and matching brackets, and getting things wrong may sometimes produce unhelpful error messages. In short, they are probably languages which those who have some basic programming experience—at the level, say, of writing an R script, Stata DO file, or SPSS syntax file—will feel more comfortable writing in.

For these developers, using a DSL may allow a substantial increase in productivity. In general, DSLs can cut development time by between 60% and 90% compared to standard, general-purpose programming approaches (Kelly & Tolvanen, 2008, 22–25). The value of using a DSL is by no means limited to those who write in it, though. As (Fowler, 2009, 14) notes:

the key value is providing a business-readable DSL, where domain experts can read the code, understand what it means, and talk to programmers directly about necessary modifications. It's much easier to make DSLs business readable rather than business writable, but you gain most of the benefits by enhancing communication.

3.1.3 Introducing *websperiment*

websperiment is a prototype of an internal DSL for specifying web surveys and experiments. Its host language is Ruby, a dynamic, interpreted language (Flanagan & Matsumoto, 2008, 2). Ruby's syntax is relatively close to that of natural language, and it has strong facilities for 'meta-programming', a means of extending the language by using code that itself writes code. These attributes make it well suited to creating internal DSLs (in fact, many current Ruby users were introduced to the language by a popular DSL for writing generic web applications, Rails⁶).

As with other DSLs, the intention of *websperiment* is that domain experts should be able to understand a survey that is implemented in it just by reading the code, even if they do not initially feel confident writing this code themselves. With that hope in mind, a very simple first example is presented: a survey with two pages and two questions. The DSL code is shown in Listing 1, and the resulting survey in Figure 6.

In Listing 1, line 1 creates a new survey. By default the survey's title, which is shown at the top of the browser window and at the top of the web page, is taken from the name given on this line (here, for example `S::ExampleSurvey` becomes "Example survey"). The content of the survey is defined by the block, surrounded by `do ... end` markers, that starts on this line and comprises the rest of the listing. Within that block, line 2 introduces the pages of the survey, whose definitions then start on lines 3 and 16. As is the case for the survey as a whole, the content of each page is defined in the `do ... end` block immediately following its declaration. The first page contains some text, followed by two questions (again defined by the `do ... end` blocks that follow them). The second page contains only some text, and a declaration that this page completes the survey.

Admittedly, this is not a very interesting survey. In fact, it stays well within what is possible using a free web-based service. However, the key advantage of the DSL approach is that it allows for this near-effortless implementation of standard survey features, without constraining the researcher's freedom to do essentially anything at all.

The example survey page in Listing 2 and Figure 7 gives a simple illustration of both of these aspects. It specifies how to deal with blank responses using a simple declaration (lines 12 – 13).

⁶<http://rubyonrails.org/>.

```

1 S::ExampleSurvey = S::Base.declare_new do
2   pages(
3     P::BasicInformation = P::Base.declare_new do
4       text "Please tell us a little about yourself."
5       questions(
6         Q::Male = Q::Radio.declare_new do
7           text "Are you male or female?"
8           options [1, "Male"],
9             [0, "Female"]
10          end,
11          Q::HomePostcode = Q::Postcode.declare_new do
12            text "What is your home postcode?"
13            end
14          )
15        end,
16        P::ThankYou = P::Base.declare_new do
17          text "Many thanks for completing this survey."
18          completes_survey true
19        end
20      )
21    end

```

Listing 1: *websperiment* code specifying a simple web survey.

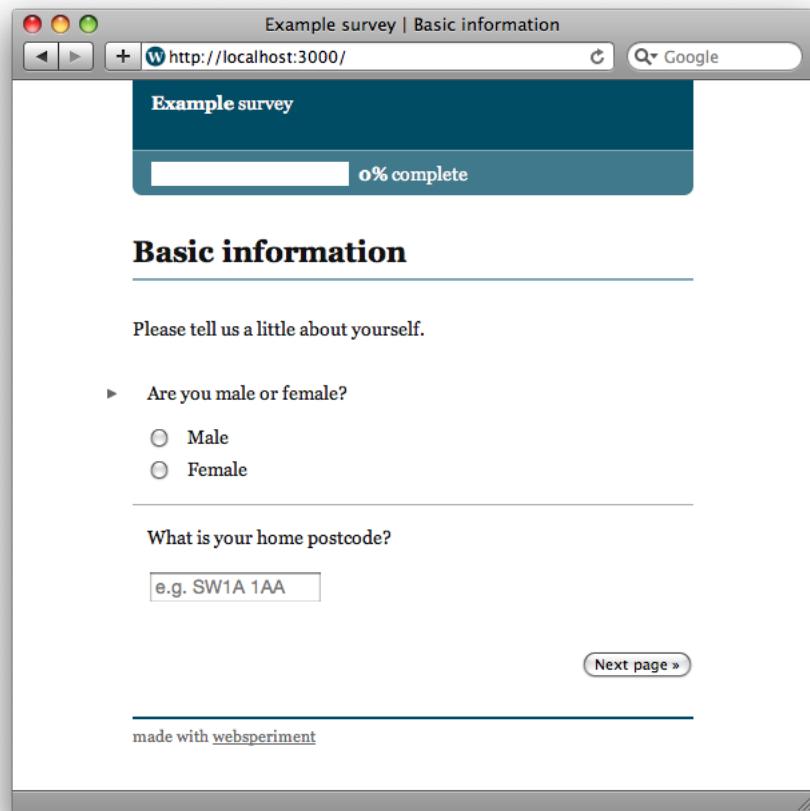


Figure 6: First page of the survey specified in Listing 1.

```

1 P::EnvironmentalConcern = P::Base.declare_new do
2   questions(
3     Q::ContactedMP = Q::Radio.declare_new do
4       require "twfy"
5       mp = Twfy::Client.new("MY_API_KEY").mp(postcode: Q::HomePostcode.answer) rescue nil
6       text "*#{mp.full_name}* -- #{mp.party} MP for #{mp.constituency.name} -- is your MP.",
7         style: :info unless mp.nil?
8       text "Have you ever contacted your MP about an environmental issue?"
9       options [1, "Yes"],
10      [0, "No"],
11      [99, "Not sure"]
12     completion :prompted,
13     message: "*Did you miss this question?* You don't have to answer, but knowing whether
14     you have contacted your MP would be very useful to our research."
15   end
16 end

```

Listing 2: Page with a dynamic question, using a previous answer and an external web service.

It also uses the web service API of the They Work For You (TWFY) web site⁷ to look up a UK respondent's local MP based on a postcode entered on the previous page (lines 4 – 5) and display this as part of the question text (lines 6 – 7).⁸

3.2 ...with inheritance...

websperiment gains some of its most useful capabilities from an approach known as object-oriented programming (OOP). OOP has its roots in the 1960s, and has been mainstream in software development for several decades.

The objects of OOP are conceptually cohesive entities that generally model and reflect things in the outside world. Objects consist both of data and of behaviours (or 'methods') that work with that data. Objects interact by passing messages, which ask that specific methods be invoked. OOP uses these objects, and their interactions, in the design and implementation of larger systems (Snyder, 1986; Armstrong, 2006). For example, OOP is increasingly used in agent-based modelling (Benenson & Torrens, 2004): objects in these studies can model agents such as the vehicles within traffic flows, or households making decisions regarding where to locate within a region (Torrens & Nara, 2007).

OOP systems commonly make a distinction between a *class*, which is the definition or 'blueprint' for an object, and an *instance*, which is a specific realisation of its class. However, since almost every object in *websperiment* is a *singleton* object — one which is intended only ever to have a single instance — this distinction not important in the use of the DSL.

websperiment is built using three main families of objects. At the core are question objects (these have names that start with Q::). For display, questions are composited into page objects (starting with P::), and for navigation from page to page, pages are composited into Survey objects (S::).

Objects in an OOP system can 'inherit' data and behaviours from other objects in a hierarchy or tree. This makes it easy to create objects that build on or modify the abilities of other objects. In OOP terminology, one creates subclasses of (or one simply 'subclasses') the original object class.

This process was seen in action in Listing 1. When the first survey page was created, it was declared as a new subclass of the basic page class, P::Base (by the line P::BasicInformation =

⁷See <http://theyworkforyou.com> and <http://github.com/bruce/twfy>.

⁸In Ruby, and therefore *websperiment*, #{} does string interpolation: code placed between the curly braces within a string of text is executed and substituted into that text.

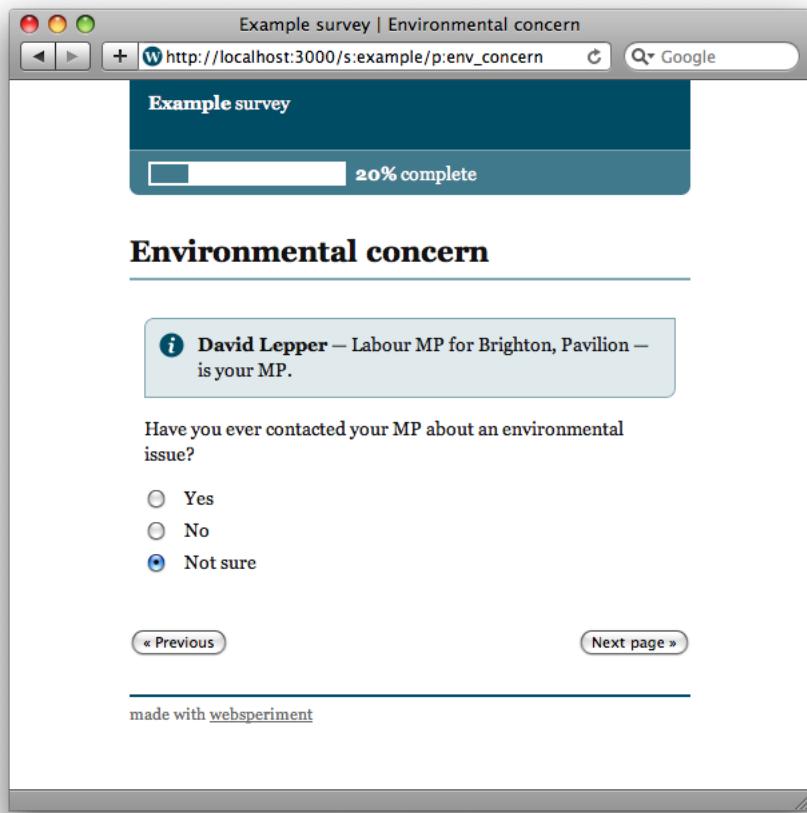


Figure 7: Survey page specified in Listing 2.

`P::Base.declare_new`). The new page therefore inherited all the standard data and behaviours required of a survey page: generating an HTML form, displaying progress through the survey as a progress bar, and so on. A block of code was then added, between the `do ... end` markers, to augment this with custom data and behaviours (in this case, some text and some questions).

Similarly, the gender question, `Q::Male`, was created as a new subclass of a radio-button question class, `Q::Radio`. It thus inherited all the data and behaviours required of a radio-button question: specifying response options, displaying these as radio buttons, and subsequently processing the respondent's selection. Again, additional data and behaviours were then specified in the subsequent block of code (in this case, some question text and two response options).

There is in fact no conceptual distinction between question classes that are built in to *websperiment* and those that are created by a researcher: all built-in classes are created in exactly the same way that new custom classes are. For example, the `Q::Postcode` class used in Listing 1 inherits from the `Q::Text` class, which itself inherits from a basic question class, `Q::Base`. At each level of the inheritance hierarchy, new data and behaviours build on those already defined. This hierarchy for `Q::Postcode`, and some examples of the behaviours defined at each level, are illustrated in Figure 8.

3.2.1 Templating with abstract classes

Subclassing is not limited only to the built-in question, page and survey classes. Say, for example, that a researcher wants to ask respondents a sequence of several yes/no questions, and include an indication of their certainty about each response. The researcher could create new intermediate

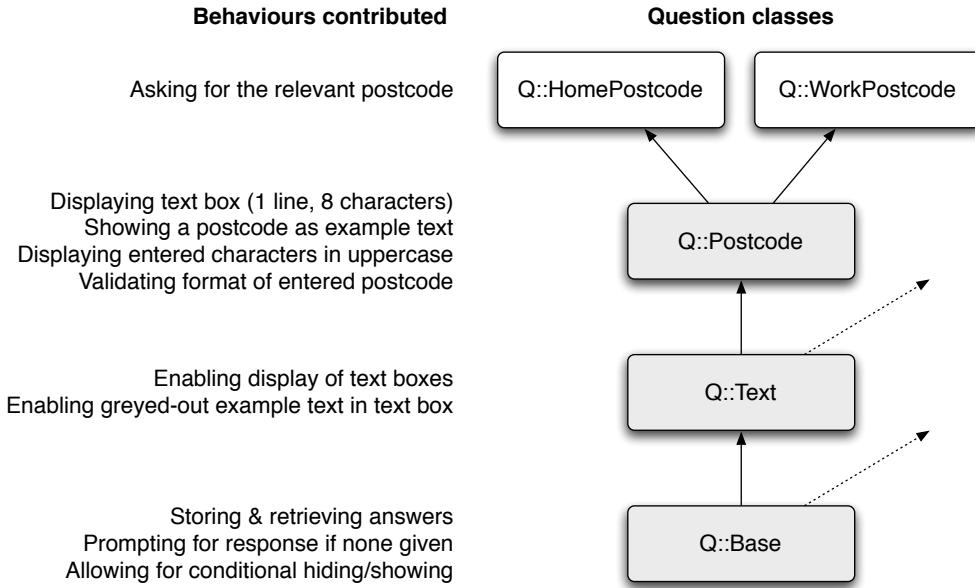


Figure 8: Inheritance hierarchy for postcode questions.

question subclasses for this purpose (they might be named `Q::YesNo` and `Q::Certainty`). These intermediate subclasses are never themselves displayed, and do not appear when the response data is downloaded from the survey, because they are never directly added to any page. In OOP terminology they are known as *abstract classes*, and in *websperiment* they act as templates. Within the pages of a survey, these abstract classes can be subclassed as necessary.

Listing 3 and Figure 9 illustrate this. The `insert_future_layout` declaration (line 2) specifies where the content contributed by any descendant question classes should be inserted. The horizontal scale question class subclassed by the certainty class (line 7) provides a new kind of declaration, `scale`, which is used to define the placement of the response scale and its numeric range and labels (lines 9 – 11).

If the researcher later decides to switch from a 1 – 5 scale to a 0 – 100% scale, all he or she has to do is modify the `Q::Certainty` class, and the change is automatically reflected in all the questions which subclass and thus inherit from it. This helps to eliminate repetition, reduce inconsistencies, and improve the maintainability of the survey code. The `Q::Certainty` subclass could be reused elsewhere in the same survey, and in any of the researcher's future surveys. It could also be shared with other researchers, for use in their surveys.

The example given above is short and simple enough that the advantages of these possibilities are not very great. However, question, page and survey classes need not be limited to a few simple lines of layout. As seen in the next subsection, they may include complex customised styling, content and logic, on both the server and the client (the web browser).

3.2.2 Advanced question types

Question types may be designed to collect survey paradata. Some of these are datum (`Datum::`) classes. These are similar to question (`Q::`) classes, in that they record an item of information for each respondent; however, they do not cause anything to be shown to the respondent (or even to be sent to their web browser). For example, the following are all available within *websperiment*:

- a `Datum::TimeViewed` class which, rather than asking the respondent any question, records the time he/she arrives on a page (which can be used to calculate the time spent on each

```

1 Q::YesNo = Q::Radio.declare_new do
2   insert_future_layout
3   options [1, "Yes"],
4           [0, "No"]
5 end
6
7 Q::Certainty = Q::ScaleHorizontal.declare_new do
8   text "How certain are you of this?"
9   scale range: 1..5,
10    start: "Uncertain",
11    end:   "Certain"
12 end
13
14 P::PurchasingDecisions = P::Base.declare_new do
15   questions(
16     Q::FivePounds = Q::YesNo.declare_new do
17       text "Would you buy item X for £5?"
18     end,
19     Q::FivePoundsCertainty = Q::Certainty.declare_new,
20     Q::TenPounds = Q::YesNo.declare_new do
21       text "Would you buy item X for £10?"
22     end,
23     Q::TenPoundsCertainty = Q::Certainty.declare_new
24   )
25 end

```

Listing 3: Simple inheritance example.

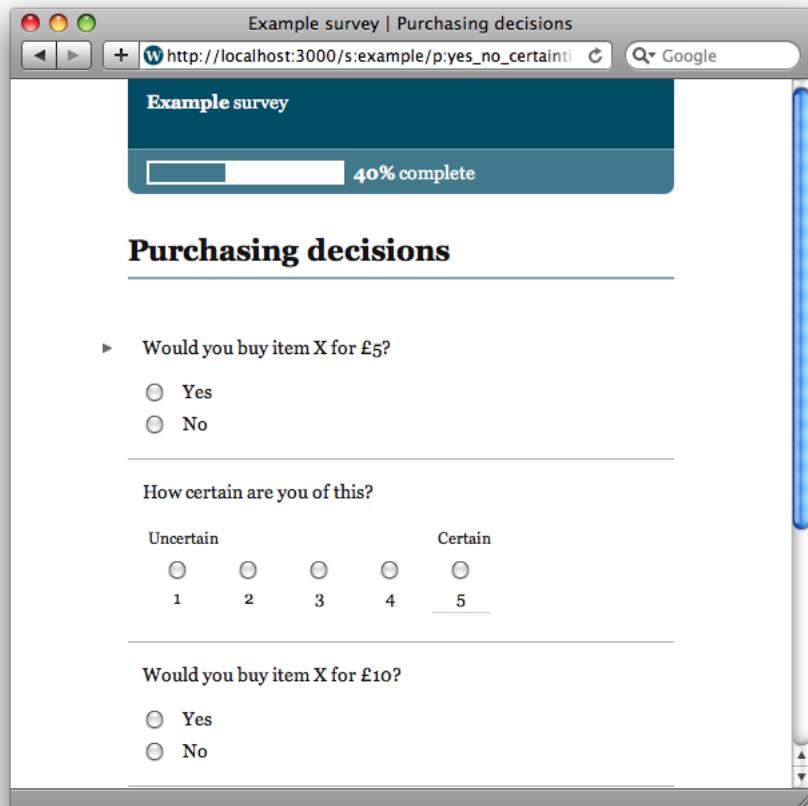


Figure 9: Survey page specified in Listing 3.

```

1 P::MapLocation = P::Base.declare_new do
2   questions(
3     Q::HomeMapLocation = Q::MapLocation.declare_new do
4       depends_on Q::HomePostcode
5       text "*Please click and drag* to move the map so that your home is inside the yellow box."
6       map start_location: Q::HomePostcode.answer,
7           size:           "390x300"
8     end
9   )
10 end

```

Listing 4: Using the map location question class.

page);

- a Q::AnswerHistory class, which automatically monitors another question and records the sequence of answers selected;
- a Q::LinkVisited class, which interrogates the respondent's web browser history to determine whether he/she has recently visited a specific web address⁹; and
- a Datum::CityFromIPAddress class, which uses public geo-location data to determine where a respondent is located.

Wholly new interactive question types can also be developed, such as visual analog scales (Couper et al., 2006) or interactive maps. For a recent survey in which precise geographical location was an important variable a Q::MapLocation class was created. This asks the respondent to pinpoint a precise location by dragging a satellite mapping image, and records the latitude and longitude of that location, as shown in use in Listing 4 and Figure 10.

In Listing 4, the map location question provides a new type of declaration, map (lines 6 – 7), which specifies where the map is to be displayed within the question content, its size in pixels, and its starting location, the latter based in this case on the answer to a previous question. The map question is also declared as dependent on the postcode question whose answer it uses to centre the map initially displayed (line 4). The effect of this is to clear the location recorded if the respondent goes back and changes the postcode entered, with the effect that the map is re-centred on the newly entered postcode.

3.3 ...that is open source

Of course, not every researcher will have the expertise in Ruby (for the server) or HTML, JavaScript, and CSS (for the client) to create advanced subclasses of this kind. However, it is easy to use subclasses created and shared by others. Anyone can use Q::MapLocation in the way shown in Listing 4 simply by downloading the code for the class and adding it to their *websperiment* library. This is very similar to the way in which capabilities can be added to R or Stata by downloading modules or packages created by others. For the survey realm, it seems somewhat overdue.¹⁰

To facilitate such sharing, *websperiment* is built wholly from open-source parts, and its own code is also released under an open-source licence. This means that researchers are free to download, modify, run and distribute the code. This makes *websperiment* particularly compatible with an

⁹Obviously a respondent's informed consent must be sought before deploying a survey item of this type.

¹⁰Of course, there is no obligation to share code, and a class that reveals too much about confidential research might be unsuitable for sharing. Additionally, to guard against the proliferation of poorly-written or excessively similar classes, some form of curated repository might turn out to be of benefit in the longer term.

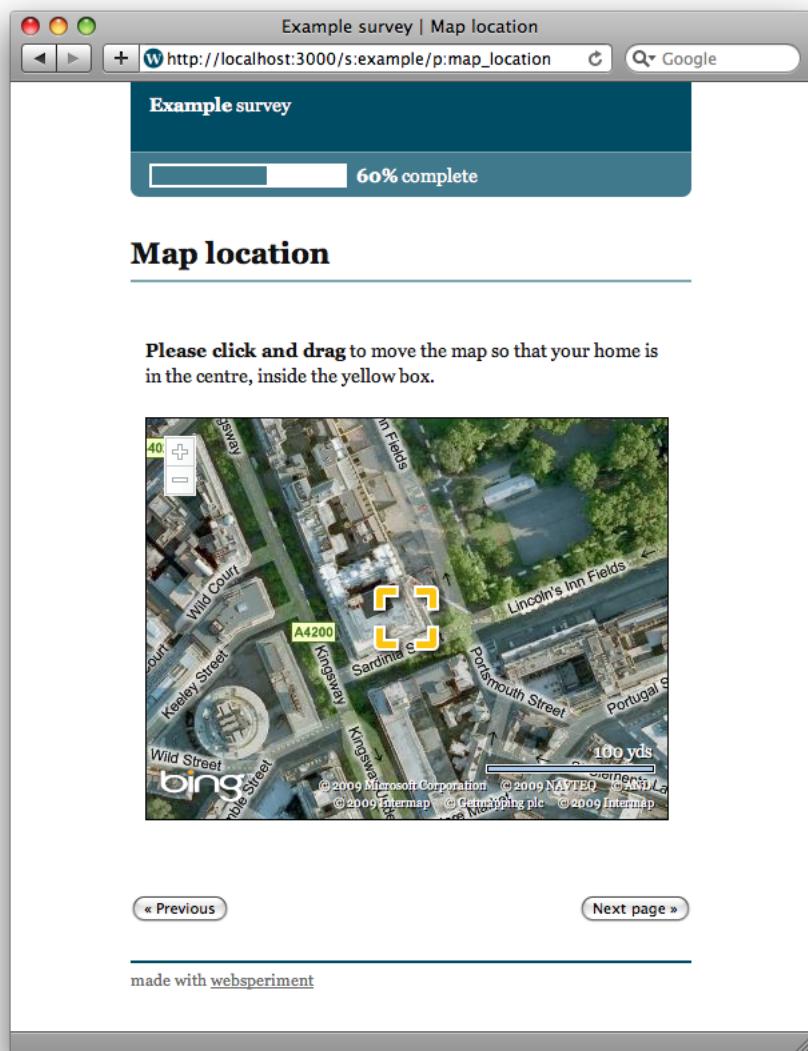


Figure 10: Survey page specified in Listing 4.

academic ethos and the scientific method.¹¹ Collaborative working, transparency, peer review, and reproducibility are all made easier to achieve, since surveys (as well as the whole DSL framework) can be easily shared, evaluated, modified, improved, and re-run.

3.4 Technical notes

Although defaults have been chosen with care, the presentation of surveys is entirely customisable. Ease of customisation depends, obviously, on the extent of the customisations desired. Images are easily included within question and page declarations. Colours, fonts, and dimensions can be altered with simple modification to CSS stylesheets. Larger structural changes might require modification of HTML templates, or tweaks to the Ruby code.

On the respondent side, surveys are marked up in standards-compliant HTML, CSS and JavaScript, and are compatible with all major browser platforms, including Internet Explorer 6+, Mozilla (including Firefox), Webkit (including Safari, Chrome, the iPhone's Mobile Safari, and the Android Browser) and Opera. All built-in JavaScript is unobtrusive, in the sense that users without it are still able to complete the survey, although questions that rely on JavaScript may be unavailable, and there may be intra-page routing instructions to follow.

On the server side, *websperiment* requires Ruby 1.9 and various Ruby *gems* (libraries), including Rails 2.3. Like any Rails application, it can be hosted by various web server packages—Apache or Nginx, with the Phusion Passenger module, are recommended—and it works with major databases including MySQL, PostgreSQL, Oracle and SQL Server. Someone comfortable working at the command line could expect to get these different elements of the system installed and running in well under an hour.

4 Extending *websperiment* for choice experiments

A surveys DSL is well suited to constructing web-based choice experiments, since these can be relatively complex and dynamic surveys. For a recent study on vehicle fuel choice, several reusable custom object classes were developed within *websperiment*. These classes are now shared as part of the *websperiment* library for other researchers to use (though the creation of such classes from scratch is not necessarily a major task: those discussed below represent no more than than a day's work). This section discusses a bare-bones choice experiment based on these classes.

The experiment aims to value CO₂ emissions and engine performance characteristics of vehicle fuels. It retrieves UK fuel price data in real-time, dynamically setting the 'status quo' fuel price as the current average fuel price within 10 miles of the respondent's postcode,¹² and all other fuel price attribute levels as deviations from this value. It assembles choice cards (see Figure 11) out of options that are random combinations of attribute levels, eliminating cards where any option is duplicated, or dominated by any other. Finally, it routes respondents who choose the status quo option every time to a special debriefing page (pictured in Figure 12).

The experiment is viewable online at <http://choicesurvey.websperiment.org/>. Its DSL source is under 100 lines of code, described further below and shown in full in Listings 5 – 9. Note that it is *not* intended to represent good survey design or good experimental design, but only to demonstrate the potential benefits of a DSL in this context.

¹¹For further discussion of the relationship between academia and open source software, see Lerner & Tirole (2005).

¹²According to <http://petrolprices.com/>.

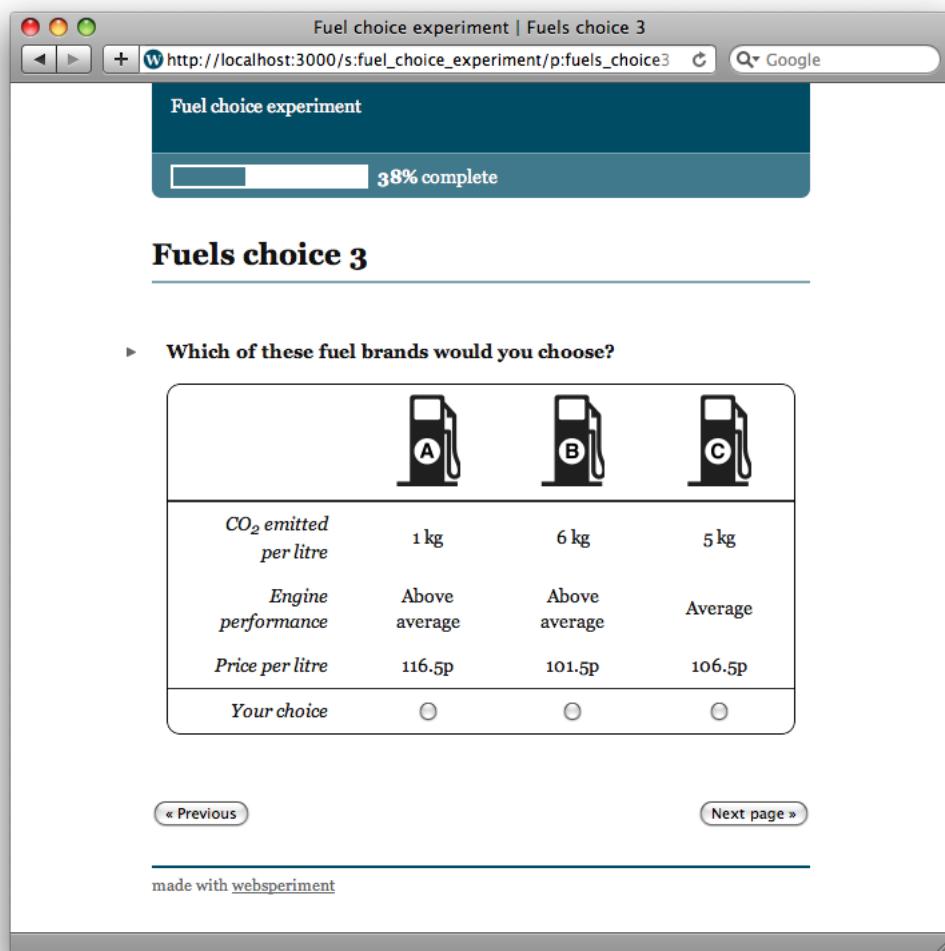


Figure 11: Survey page showing randomised choice card with dynamic price attribute levels.

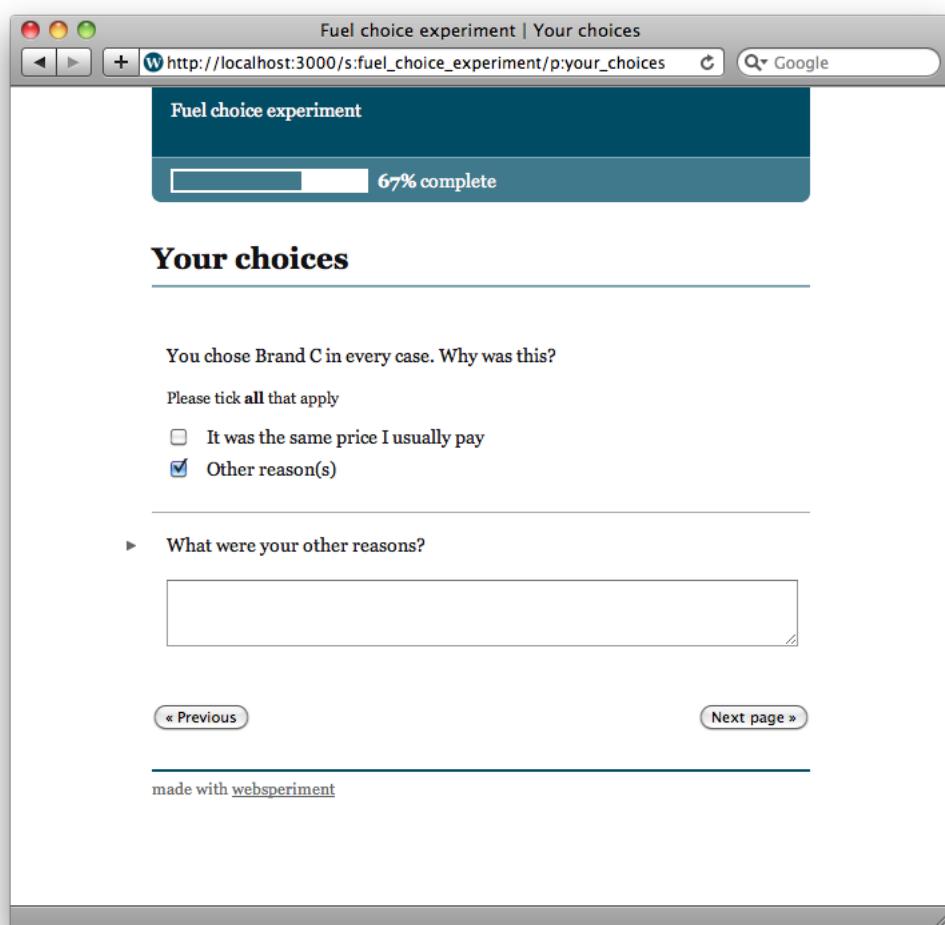


Figure 12: Follow-up survey page to be shown based on choice pattern.

```

1 P::HomePostcode = P::Base.declare_new do
2   questions(
3     Q::HomePostcode = Q::Postcode.declare_new do
4       text "What is your home postcode?"
5     end
6   )
7 end
8
9 Datum::StatusQuoPrice = Datum::LocalFuelPrice.declare_new do
10 depends_on Q::HomePostcode
11   get_price_for_postcode: Q::HomePostcode.answer,
12   fallback_price: 109
13 end

```

Listing 5: Determining the average fuel price in the respondent's local area.

```

1 Datum::FuelSet = Datum::AttributeSet.declare_new do
2   depends_on Datum::StatusQuoPrice
3   attribute :co2_emitted,
4     levels: 1..9,
5     status_quo: 5,
6     more_is: :worse
7   attribute :engine_performance,
8     levels: 0..2,
9     status_quo: 1,
10    more_is: :better
11   attribute :price,
12     levels: [-10, -5, 0, 5, 10].map { |d| d + Datum::StatusQuoPrice.value },
13     status_quo: Datum::StatusQuoPrice.value,
14     more_is: :worse
15 end
16
17 Datum::ThreeWayFuelSet = Datum::FuelSet.declare_new do
18   random_set labels: ["a", "b"],
19   status_quo_label: "c"
20 end

```

Listing 6: Defining choice attributes and levels.

4.1 Getting a local fuel price

The first page of the survey simply requests the respondent's postcode, as in the first example (subsubsection 3.1.3). This postcode is then used by a simple custom `Datum::` class to retrieve the average local fuel price (because it is a `Datum::` class, it stores a value alongside the respondent's answers, but does not display anything to the respondent).

These steps are seen in Listing 5. On line 9, the status quo price item is defined as a subclass of the local fuel price item. On line 10, it is made dependent on the postcode question (so that its value will be cleared and recalculated whenever the answer to that question changes). On line 11, it is set to retrieve the price for the postcode provided by the respondent. On line 12, a fallback price is specified: this fallback price will be used if no postcode is provided, or if the postcode is not recognised, or if the request to [petrolprices.com](#) fails to return an answer within an acceptable timeout period.

4.2 Defining attributes

The next step in creating the choice experiment is defining the attributes and levels. This is accomplished using another reusable custom `Datum::` class, as seen in Listing 6.

The first attribute is defined on lines 3 – 6. Line 3 gives the attribute a name, by which it can be identified elsewhere in the code. Line 4 defines its levels: the series of integers from 1 to 9 inclusive. Line 5 specifies the status quo level, which will be used as the value for the status quo option to be shown on every choice card. Line 6 specifies that higher values are less desirable: this information enables the randomisation algorithm to detect when one option (i.e. a combination of levels) is dominated by another.¹³ For qualitative attributes, or other attributes where the desirability of different levels is not known in advance, this line would be omitted.

The second attribute is defined similarly on lines 7 – 10, and the third on lines 11 – 14. For the third attribute, the status quo level is set dynamically to the respondent's local fuel price as already queried online (line 13). The full set of levels is then defined as deviations from this value (line 12).¹⁴ For this reason, the whole attribute set is specified as dependent on the status quo price (line 2). This means that if there is a change in the status quo price (which could in this case be caused only by a change to the postcode), the attribute levels will be cleared and recalculated accordingly.

Then, having defined the attributes and their levels, attributes must be combined into options, and options combined into choice cards. This is accomplished by lines 17 – 20, which specify that two randomised options are to be generated, labelled 'a' and 'b', alongside a status quo option, labelled 'c'.

4.3 Displaying choice cards

Once created, the choice cards must be displayed to respondents (as illustrated in Figure 11). This is achieved by a custom question (Q::) class, as seen in Listing 7. This class allows formatting to be specified for each attribute, and then displays HTML tables based on specific sets of attribute values as generated in Listing 6.

Lines 1 – 13 of Listing 7 define the formatting to be used for the choice card. On line 3, the option labels ('a', 'b', and 'c') are used as parts of the file names of images which are used as the table headings. Lines 4 – 12 define the attribute titles and formatting (on line 9, the engine performance attribute is used as an index to an array of text strings: thus, when the attribute level is 0, 'Below average' will be displayed; when it is 1, 'Average' will be displayed; and so on).

Lines 15 – 23 define the choice card survey page. Line 16 creates a new set of attribute levels (as a subclass of the second Datum:: class defined in Listing 6). The new class is named not by assignment—the way that has been seen before (e.g. Datum::X = Datum::Y.declare_new)—but using the method named_with_suffix, which simply appends a number or text string as a suffix to the name of the class that is being subclassed. The argument passed to this method here—name_suffix—returns the suffix part of the page's own name (since, as will be seen in Listing 9, the choice card survey pages are themselves named using the named_with_suffix method). The new class is also assigned to a local variable, choice_attributes, for later use.

Line 17 adds the newly created set of attribute levels to the page (and hence to the survey: without this line, the levels would not be stored). Finally, the choice card question is added to the page on lines 18 – 23. Line 21 specifies that the question should display the attribute levels created on line 16. Line 20 specifies the question's dependency on these levels: if the levels change (due to change in the status quo price, due to a change in the postcode), the answer entered for this question will be cleared. On line 22 the choice card question is named using named_with_suffix.

¹³Option A is dominated by option B if it is worse than B in one or more of its attributes, and not better in any.

¹⁴The map method on line 12 maps the array of values on its left to a new array of values, by passing each original value into the block that follows, as the value of the variable d, and using the values returned by the block as the values comprising the new array.

```

1 Q::FuelsCard = Q::ChoiceCard.declare_new do
2   text "*Which of these fuel brands would you choose?*"
3   label_format -> l { "/images/pump_{l}.png(Brand #{l.upcase})!" }
4   display :co2_emitted,
5     title: "CO2 emitted per litre",
6     format: -> c { "#{c} kg" }
7   display :engine_performance,
8     title: "Engine performance",
9     format: -> ep { ["Below average", "Average", "Above average"][ep] }
10  display :price,
11    title: "Price per litre",
12    format: -> p { "#{p}p" }
13 end
14
15 P::FuelsChoice = P::Base.declare_new do
16   choice_attributes = Datum::ThreeWayFuelSet.declare_new.named_with_suffix(name_suffix)
17   datum choice_attributes
18   questions(
19     Q::FuelsCard.declare_new do
20       depends_on choice_attributes
21       attributes choice_attributes.value
22     end.named_with_suffix(name_suffix)
23   )
24 end

```

Listing 7: Formatting choice cards.

The choice card page and question classes are named using suffixes because they will be subclassed, and added to the survey, multiple times—once each per choice card—but still require unique names by which they may be identified (both elsewhere in the survey and when saving and reporting the respondents’ answers).

4.4 Following up response patterns

Once the respondent has made the choices presented, it may be valuable to ask follow-up debriefing questions in response to specific choice patterns. In this example, respondents who always choose option C (the status quo option) are asked their reasons for doing so. This is illustrated in Figure 12, and the DSL code is shown in Listing 8.

Of greatest interest here are probably lines 10 – 11. These lines specify that the second question is

```

1 P::YourChoices = P::Base.declare_new do
2   questions(
3     Q::StatusQuoAlwaysReason = Q::Checkbox.declare_new do
4       text "You chose Brand C in every case. Why was this?"
5       text "Please tick *all* that apply", style: :smaller
6       options [:price, "It was the same price I usually pay"],
7                 [:other, "Other reason(s)"]
8     end,
9     Q::StatusQuoAlwaysOther = Q::Text.declare_new do
10      show_if "Q::StatusQuoAlwaysReason.answer.include? :other",
11              human: "you chose 'Other reason(s)' above"
12      text "What were your other reasons?"
13      text_box size: "70x3",
14                  full_width: true
15   end
16 )
17 end

```

Listing 8: Debriefing page for a specific choice pattern, as shown in Figure 12.

```

1 P::Thanks = P::Base.declare_new do
2   text "*Thank you* for completing this survey"
3   completes_survey true
4 end
5
6 S::FuelChoiceExperiment = S::Base.declare_new do
7   n = 3
8   page P::HomePostcode
9   (1..n).each { |card_no| page P::FuelsChoice.declare_new.named_with_suffix(card_no) }
10  pages(
11    P::YourChoices, skip_unless { (1..n).all? { |card_no| eval("Q::FuelsCard#{card_no}").answer == 'c' } },
12    P::Thanks
13  )
14 end

```

Listing 9: Pulling the experiment together.

to be displayed only where the respondent ticks the 'Other reason(s)' check-box on the first question. Line 10 gives the condition in *websperiment* (Ruby) format (this condition is also translated into JavaScript, for use by the respondent's web browser¹⁵). Line 11 gives the condition as it is to be displayed to the respondent, if JavaScript is for any reason unavailable in the browser.

4.5 Putting the experiment together

Finally, the components seen above need to be integrated into a survey, as shown in Listing 9. Lines 1 – 4 define an acknowledgement page. On line 2, note the use of asterisks (*) around some of the text. This is one example of the Textile markup system used by *websperiment*: it causes the text to be displayed in **boldface**.¹⁶

Lines 6 – 14 define the overall survey object, bringing together the previously-defined page objects. Line 7 sets the number of choice cards to be displayed, as a local variable n. Line 8 adds the postcode question page to the survey. On line 9 all the choice choice card pages are added, as follows: the integers 1 to n are passed into the block as the value of card_no, and a new subclass of the P::FuelsChoice page is created each time, named with that integer as a suffix (P::FuelsChoice1, P::FuelsChoice2, and so on), and added to the survey by the page declaration. Lines 10 – 13 add the follow-up debriefing page and the acknowledgement page, and line 11 also defines the condition according to which the debriefing page will be displayed (it will be skipped unless option 'c' was selected on *all* of the choice cards).

5 Conclusions

Researchers have up to now usually had to pick one of four main options when implementing surveys and choice experiments online: web-based services, local software, consultants, or Do-It-Yourself from scratch.

Implementing a web-based survey or experiment using a DSL such as the *websperiment* prototype, it has been argued, has a number of advantages over the options previously available. These include: improved productivity, leading to reduced time and cost of implementation; greater flexibility

¹⁵The 'translation' is accomplished using an enhanced version of a system called HotRuby: see <http://hotruby.yukoba.jp/> and <http://github.com/STRd6/hotruby>.

¹⁶For further details, see <http://redcloth.org/textile>.

and extensibility, enabling arbitrarily advanced features; and wider accessibility and browser compatibility, permitting a broader sampling frame and a superior experience for respondents.

The advantages also include easier communication and sharing, both within a specific research project and (where relevant) more broadly within the academic process. This is for three main reasons: first, because the DSL is readable by domain experts who need not be experts in web survey implementation; second, because it is designed in a modular way, using reusable, sharable classes; and third, because it is unencumbered by proprietary licence restrictions.

websperiment has already been used to implement several online surveys and experiments, but it is not a finished product. Researchers are strongly encouraged to use and contribute to the development of the project.

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A.5 Survey source listings

A.5.1 London

```
1 # encoding: utf-8
2
3 # London wellbeing and EQ survey
4 # George Mackerron 2009
5 #
6 #
7 (# Reusable question types
8 Q::Satisfaction = Q::ScaleHorizontal.declare_new do
9   insert_future_layout
10  scale :range => 0..10,
11    :start => "Extremely \n dissatisfied",
12    :end => "Extremely \n satisfied"
13 end
14
15 Q::Frequency = Q::Radio.declare_new do
16   insert_future_layout
17
18   # from ESS q C2 -- required for ESS wellbeing module, social meeting q
19   options [7, 'Every day'],
20     [6, 'Several times a week'],
21     [5, 'Once a week'],
22     [4, 'Several times a month'],
23     [3, 'Once a month'],
24     [2, 'Less than once a month'],
25     [1, 'Never']
26 end
27
28 Q::YesNo = Q::Radio.declare_new do
29   insert_future_layout
30   options [1, 'Yes'], [0, 'No']
31 end
32
33 Q::EssFrequency = Q::Radio.declare_new do
34   insert_future_layout
35   options [1, 'At least once a week'],
36     [2, 'At least once a month'],
37     [3, 'At least once every three months'],
38     [4, 'At least once every six months'],
39     [5, 'Less often'],
40     [6, 'Never']
41 end
42
43 Q::EssAgreement = Q::RadioHorizontal.declare_new do
44   insert_future_layout
45   options [5, 'Disagree strongly'],
46     [4, 'Disagree'],
47     [3, 'Neither agree nor disagree'],
48     [2, 'Agree'],
49     [1, 'Agree strongly']
50 end
51
52 Q::EssTime = Q::RadioHorizontal.declare_new do
53   insert_future_layout
54   options [1, 'None or almost none of the time'],
55     [2, 'Some of the time'],
56     [3, 'Most of the time'],
57     [4, 'All or almost all of the time']
58 end
59
60 Q::EssTimeProportion = Q::ScaleHorizontal.declare_new do
61   insert_future_layout
62   scale :range => 0..6,
63     :start => "None of\nthe time",
64     :end => "All of\nthe time",
65     :others => [[:na, '', "Doesn't\\napply"]]
66 end
67
68 Q::EssTimeProportionNoNa = Q::ScaleHorizontal.declare_new do
69   insert_future_layout
70   scale :range => 0..6,
71     :start => "None of \n the time",
72     :end => "All of \n the time"
73 end
74
75 Q::EssAgreementScale = Q::ScaleHorizontal.declare_new do
76   insert_future_layout
77   scale :range => 0..6,
78     :start => "Not \n at all",
79     :end => "A great \n deal"
80 end
81
82 Q::EssSatisfaction = Q::ScaleHorizontal.declare_new do
83   insert_future_layout
84   scale :range => 0..10,
```

```

85      :start => "Extremely \n dissatisfied",
86      :end => "Extremely \n satisfied"
87  end
88
89  Q::EssImportance = Q::ScaleHorizontal.declare_new do
90    insert_future_layout
91    scale :range => 0..6,
92      :start => "Not at all \n important",
93      :end => "Very \n important"
94  end
95
96  class Q::BorderlessPostcode < Q::Postcode
97    include Q::Borderlessness
98  end
99  class Q::UnclearedCheckbox < Q::Checkbox # FF reacts weirdly to this when scriptaculousing, and IE just ignores it
100 end
101
102 Q::ScaleOfProblem = Q::RadioHorizontal.declare_new do
103   insert_future_layout
104   options [1, "A serious problem",
105             [2, "A problem, \n but not serious"],
106             [3, "Not a problem"]
107           #options [4, 'Very big problem'],
108           #           [3, 'Fairly big problem'],
109           #           [2, 'Not a very big problem'],
110           #           [1, 'Not a problem at all']
111 end
112
113 Q::ReligiousFrequency = Q::Radio.declare_new do
114   insert_future_layout
115   options [1, 'Every day',
116             [2, 'More than once a week'],
117             [3, 'Once a week'],
118             [4, 'At least once a month'],
119             [5, 'Only on special holy days'],
120             [6, 'Less often'],
121             [7, 'Never']
122 end
123 Q::SleepHours = Q::Dropdown.declare_new do
124   insert_future_layout
125   options [3, '3 hours or fewer'],
126             [3.5, '3.5 hours'],
127             [4, '4 hours'],
128             [4.5, '4.5 hours'],
129             [5, '5 hours'],
130             [5.5, '5.5 hours'],
131             [6, '6 hours'],
132             [6.5, '6.5 hours'],
133             [7, '7 hours'],
134             [7.5, '7.5 hours'],
135             [8, '8 hours'],
136             [8.5, '8.5 hours'],
137             [9, '9 hours'],
138             [9.5, '9.5 hours'],
139             [10, '10 hours or more']
140 end
141 Q::Income = Q::Dropdown.declare_new do
142   insert_future_layout
143   text 'If you are not certain of an amount, please give your best estimate.', :style => :smaller
144   options monetary_bands [:unbounded,
145                           4000,
146                           6000,
147                           8000,
148                           10000,
149                           12000,
150                           15000,
151                           18000,
152                           20000,
153                           23000,
154                           26000,
155                           29000,
156                           32000,
157                           38000,
158                           44000,
159                           50000,
160                           56000,
161                           68000,
162                           80000,
163                           100000,
164                           150000,
165                           200000,
166                           400000,
167                           800000,
168                           :unbounded]
169 end
170 )
171
172 #
173 (# Custom page stuff
174 Q::MetaQuestion = Q::Text.declare_new do
175   text '*Survey pilot phase.* Please enter any comments or suggestions here.'

```

```

176   text_box :size => '70x5', :full_width => true
177   completion :optional
178   no_next_prompt
179 end
180
181 Q::PageComment = Q::Text.declare_new do
182   show_if :js_condition => "return window.Websperiment$add_comment;",
183   :human_condition => "This question is completely optional."
184   text 'If there's anything you'd like to add, please use this space.'
185   text_box :size => '70x3', :full_width => true
186   completion :optional
187   no_next_prompt
188 end
189
190 class P::Wellbeing < P::Base
191   def suppress_comment; false; end
192   declare do
193     insert_future_layout
194
195     # Timing of first layout = first GET request
196     question(eval("Datum:#'{name}.demodulize}PageFirstLook = Datum::FirstLayoutTime.declare_new"))
197
198     # Add a comment link
199     unless (suppress_comment)
200       question(eval("Q:#'{name}.demodulize}PageComment = Q::PageComment.declare_new"))
201       markup %q{
202         <div class="hide_bottom_border"></div>
203         <div id="add_comment" style="display: none;"><a href="#comment" onclick="window.Websperiment$add_comment = true
204           ; $(this).up('div').hide_animated(); return false;">add a comment</a></div>
205       }
206       local_js %Q{
207         document.observe('dom:loaded', function() {
208           var p = $('#add_comment');
209           if (p) {
210             var q = Page.questions.last();
211             if (q.answer()) {
212               Websperiment$add_comment = true;
213               q.show();
214             } else p.show();
215           }
216         });
217       }
218       css %Q{
219         #add_comment { font-size: 0.85em; text-align: right; }
220         #add_comment a {
221           color: #666;
222           padding-left: 11px;
223           background: #fff url(/images/plus.png) 0% 50% no-repeat;
224         }
225       }
226
227     help_page :text => 'Help & information', :name => 'P::MoreInfo'
228
229     # Piloting meta-question
230     css '.pilot_evaluation { color: #fff; padding: 0 1em; background: #666; margin-top: 2em; }'
231     if Respondent.current.andand.referral_data.andand.match(/\bpilot\b/)
232       markup '<div class="pilot_evaluation">'
233       question(eval("Q:#'{name}.demodulize}PageEvaluation = Q::MetaQuestion.declare_new"))
234       markup '</div>'
235     end
236
237   end
238 end
239
240 )
241 #
242 (# Screening and quotas stuff
243 screening_completion_message = '*An answer is required here*, because it helps us determine whether enough people with
244   your profile have already responded to the survey.'
245 toluna_respondent_cond = -> { Respondent.current.andand.referral_data.andand.match(/\btoluna\b/) }
246
247 Q::Male = Q::Radio.declare_new do
248   text 'Are you male or female?'
249   options [1, 'Male'],
250          [0, 'Female']
251 end
252 Q::ScreeningMale = Q::Male.declare_new do
253   completion :mandatory, :message => screening_completion_message
254 end
255
256 Q::Age = Q::Dropdown.declare_new do
257   text 'What is your age?'
258   option [0, 'Under 10 years']
259   options discrete_numeric_bands [10, 16, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, :unbounded],
260   :bottom_unbounded => 'or under',
261   :top_unbounded => 'or over'
262 end
263 Q::ScreeningAge = Q::Age.declare_new do
264   completion :mandatory, :message => screening_completion_message
265 end

```

```

265 Q::WorkStatus = Q::Radio.declare_new do
266   # BHPS 2006, D29; and Families & Children Study 2006 - NatCen/DWP
267   text 'Which of these best describes your current situation?'
268   options [:self_emp, 'Self employed'],
269     [:emp, 'In paid employment (full- or part-time)'],
270     [:unemp, 'Unemployed and seeking work'],
271     [:retired, 'Retired from paid work altogether'],
272     [:parental, 'On maternity leave'],
273     [:fte, 'Full-time student or at school'],
274     [:govt_train, 'On a government training scheme'],
275     [:home_family, 'Looking after family or home'],
276     [:caring, 'Caring for a sick, elderly or disabled person'],
277     [:sick, 'Long term sick or disabled'],
278     [:other, 'Something else']
279 end
280 Q::ScreeningWorkStatus = Q::WorkStatus.declare_new do
281   completion :mandatory, :message => screening_completion_message
282 end
283
284 Q::ScreeningEarnings = Q::Radio.declare_new do
285   text 'What are your *gross* earnings in your *<=% Q::ScreeningWorkStatus.answer == :emp ? "main (or only) job" : "training scheme" %>*?'
286   options [:below_median, '£470 a week / £2,040 a month / £24,500 a year or less'],
287     [:above_median, 'More than £470 a week / £2,040 a month / £24,500 a year'],
288     [:not_sure, 'Not sure']
289   completion :mandatory, :message => screening_completion_message
290 end
291 #
292 Quotas::Wellbeing = Quotas::Base.declare_new do
293
294   quota :on => :age,
295     :categories => [:age_16_to_34, :age_35_to_54, :age_55_plus, :under_16],
296     :classify => -> {
297       a = Q::ScreeningAge.answer
298       return nil unless a
299       return :under_16 if [0, 10].include? a
300       return :age_16_to_34 if [16, 20, 25, 30].include? a
301       return :age_35_to_54 if [35, 40, 45, 50].include? a
302       return :age_55_plus
303     }
304   quota :on => :work_income,
305     :categories => [:not_employee, :below_median, :above_median, :not_sure],
306     :classify => -> {
307       ws = Q::ScreeningWorkStatus.answer
308       e = Q::ScreeningEarnings.answer
309       if [:emp, :govt_train].include?(ws)
310         e
311       else
312         :not_employee
313       end
314     }
315   quota :on => :location,
316     :categories => [:inner_london, :outer_london, :elsewhere_or_not_sure],
317     :classify => -> {
318       a = Q::ScreeningBorough.answer
319       return nil unless a
320       london_inner_e = [:hackney, :haringey, :islington, :lambeth, :lewisham, :newham, :southwark, :tower]
321       london_inner_w = [:camden, :city, :hammersmith, :kensington, :wandsworth, :westminster]
322       london_outer_e = [:barking, :bexley, :fenfield, :greenwich, :havering, :redbridge, :waltham]
323       london_outer_w = [:barnet, :brent, :ealing, :harrow, :hillingdon, :hounslow, :richmond]
324       london_outer_s = [:bromley, :croydon, :kingston, :merton, :sutton]
325       return :inner_london if (london_inner_e + london_inner_w).include? a
326       return :outer_london if (london_outer_e + london_outer_w + london_outer_s).include? a
327       return :elsewhere_or_not_sure # for Somewhere else & Don't know answers
328     }
329   quota :on => :sex,
330     :categories => [:male, :female],
331     :classify => -> {
332       a = Q::ScreeningMale.answer
333       return nil unless a
334       return :male if a == 1
335       return :female if a == 0
336     }
337
338   numbers contents_of_file 'quotas.yml'
339 end
340 )
341 #
342 class P::Welcome < P::Wellbeing
343   def suppress_comment; true; end
344 end
345 class P::MoreInfo < P::Wellbeing
346   def suppress_comment; true; end
347 end
348 class P::Thanks < P::Wellbeing
349   def suppress_comment; true; end
350 end
351 #
352 S::Wellbeing = S::Base.declare_new do
353   title '*Wellbeing survey* -- LSE'

```

```

355     quotas Quotas::Wellbeing
356     pages(
357       P::Welcome.declare do
358         text contents_of_file 'welcome_text.txt'
359         text %Q{*Want to know more?* <a href="<%= eval(help_page[:name]).url %>" target="_new">See more details now</a>, or click 'help\_page\[:text\]' at the top right of any page.}, :style => :info
360         forward_prompt 'Start survey &#187;'
361         progress_bar :hidden
362       end,
363       P::MoreInfo.declare do # mention MRS CoC, or Data Protection?
364         title help_page[:text]
365         text (contents_of_file (toluna_respondent_cond.call ? 'contact_text_toluna.txt' : 'contact_text.txt')), :style =>
366           :float_info
367         text contents_of_file 'info_text.txt'
368         text '*Please <a href="#close_window" onclick="window.close();">close this window or tab</a>* to return to the survey.', :style => :info
369         suppress_forward on
370         suppress_backward on
371         progress_bar :hidden
372         progress_weight 0
373       end,
374         skip_always,
375       P::ScreeningOne = P::Wellbeing.declare_new do
376         title 'Basic information (1)'
377         questions(
378           Q::ScreeningMale,
379           Q::ScreeningAge,
380           Q::ScreeningWorkStatus
381         )
382         progress_weight 0.5
383       end,
384         skip_unless { toluna_respondent_cond.call },
385       P::ScreeningTwo = P::Wellbeing.declare_new do
386         title 'Basic information (2)'
387         question(Q::ScreeningEarnings) if [:emp, :govt_train].include?(Q::ScreeningWorkStatus.answer)
388         questions(
389           Q::ScreeningBorough = Q::Radio.declare_new do
390             text 'Are you *currently* living in Greater London?'
391
392             text "*Yes* -- I'm living in..."
393             markup '<div class="left_3_col">'
394               options [:barking, 'Barking and Dagenham'],
395                 [:barnet, 'Barnet'],
396                 [:bexley, 'Bexley'],
397                 [:brent, 'Brent'],
398                 [:bromley, 'Bromley'],
399                 [:camden, 'Camden'],
400                 [:kensington, 'Chelsea (and Kensington)'],
401                 [:city, 'City of London'],
402                 [:westminster, 'City of Westminster'],
403                 [:croydon, 'Croydon'],
404                 [:barking, 'Dagenham (and Barking)'],
405                 [:ealing, 'Ealing'],
406                 [:enfield, 'Enfield']
407             markup '</div><div class="centre_3_col">'
408               options [:hammersmith, 'Fulham (and Hammersmith)'],
409                 [:greenwich, 'Greenwich'],
410                 [:hackney, 'Hackney'],
411                 [:hammersmith, 'Hammersmith and Fulham'],
412                 [:haringey, 'Haringey'],
413                 [:harrow, 'Harrow'],
414                 [:havering, 'Havering'],
415                 [:hillingdon, 'Hillingdon'],
416                 [:hounslow, 'Hounslow'],
417                 [:islington, 'Islington'],
418                 [:kensington, 'Kensington and Chelsea'],
419                 [:kingston, 'Kingston upon Thames'],
420                 [:lambeth, 'Lambeth']
421             markup '</div><div class="right_3_col">'
422               options [:lewisham, 'Lewisham'],
423                 [:merton, 'Merton'],
424                 [:newham, 'Newham'],
425                 [:redbridge, 'Redbridge'],
426                 [:richmond, 'Richmond upon Thames'],
427                 [:southwark, 'Southwark'],
428                 [:sutton, 'Sutton'],
429                 [:tower, 'Tower Hamlets'],
430                 [:waltham, 'Waltham Forest'],
431                 [:wandsworth, 'Wandsworth'],
432                 [:westminster, 'Westminster (City of)']
433             markup '</div><div style="clear: both;"></div>'

434             text '*No/not sure*'
435             options [:na, "No, I'm living somewhere else at the moment"],
436               [:dk, "Not sure"]

437             completion :mandatory, :message => screening_completion_message
438
439             css '.left_3_col, .centre_3_col, .right_3_col { width: 30%; float: left; }'
440             .centre_3_col, .right_3_col { padding: 0 0 0 1em; }'
441
442   end

```

```

443     )
444     progress_weight 0.5
445   end,
446   skip_unless { toluna_respondent_cond.call },
447 P::ScreenOut = P::Redirect.declare_new do
448   respondent_not_eligible true
449   destination_url (RAILS_ENV == 'production' ? 'http://as.automatesurvey.com/SOP/P299943697303072S2S' : 'http://www
        .google.com/search?q=screen_out')
450 end,
451 skip_unless { toluna_respondent_cond.call && quotas.current_respondent_out_of_scope? },
452 P::QuotaFull = P::Redirect.declare_new do
453   respondent_not_eligible true
454   destination_url (RAILS_ENV == 'production' ? 'http://as.automatesurvey.com/SOP/P299943697303072S2F' : 'http://www
        .google.com/search?q=quota_full' )
455 end,
456 skip_unless { toluna_respondent_cond.call && quotas.current_respondent_quota_full? },
457 P::LifeSat = P::Wellbeing.declare_new do # B24
458   title 'Satisfaction with life'
459
460   questions(
461     Q::LifeSat = Q::Satisfaction.declare_new do # B24
462       text "All things considered, how satisfied are you with your life as a whole nowadays?"
463       completion :prompted,
464         :message => 'We would be very grateful if you would provide a response to this question: it
        represents a key part of our research topic.'
465     end
466   )
467
468   # copy screening answers to standard answers -- naughty non-markup use of markup to execute only when this page
        viewed
469   markup '<%
470     Q::Male.answer Q::ScreeningMale.answer
471     Q::Age.answer Q::ScreeningAge.answer
472     Q::WorkStatus.answer Q::ScreeningWorkStatus.answer
473   %>' if toluna_respondent_cond.call
474
475   progress_weight 0.5
476 end,
477
478 P::Vignettes = P::Wellbeing.declare_new do
479   title "Life satisfaction of others"
480   text "*On this page we very briefly describe four people's lives. Please read the descriptions carefully,* and
        try to imagine how satisfied with their lives these people might be."
481   text "*There are no right or wrong answers---we'd just like to know your impressions based on the information
        given.", :style => :info
482
483   # using 4 of top 10 names for approximate birth date and gender, plus a contraction for each
484   # (see http://www.askoxford.com/worldofwords/name/firstnames/namesappendices/1954/?view=uk)
485   # except vignette 3: using 3 names each from muslim/arabic, indian/hindu, chinese, spanish and english names
486
487   data(
488     Datum::VignetteOneName = Datum::Base.declare_new do
489       value %w(Jonathan John Stephen Steve Andrew Andy Robert Rob).randomly_pick unless value # 1964
490     end,
491     Datum::VignetteTwoName = Datum::Base.declare_new do
492       value %w(Joanne Jo Samantha Sam Nicola Nicky Rebecca Becky).randomly_pick unless value # 1974 (except
        Rebecca, 1984)
493     end,
494     Datum::VignetteThreeName = Datum::Base.declare_new do
495       value %w(Yusuf Hakim Ahmad Rajiv Govind Prabhu Li Cheng Xin Fernando Miguel Pablo James Daniel Matthew).
        randomly_pick unless value
496       # value %w(Christopher Chris James Jim Daniel Dan Matthew Matt).randomly_pick unless value # 1984
497     end,
498     Datum::VignetteFourName = Datum::Base.declare_new do
499       value %w(Susan Sue Elizabeth Liz Margaret Maggie Patricia Pat).randomly_pick unless value # 1954
500     end
501   )
502
503   vignettes = [
504     Q::VignetteOne = Q::Satisfaction.declare_new do
505       text "_<%= Datum::VignetteOneName.value %> is 42 years old. He's single, and has no children. He makes £70
        ,000 a year in a professional job, but some colleagues have recently been laid off and his position isn
        't secure. Outside work <%= Datum::VignetteOneName.value %> watches a lot of television, and sees
        friends for a drink about once a month. He's slightly overweight, and carries an inhaler for his asthma
        ."
506       text 'How satisfied with his life as a whole do you think <%= Datum::VignetteOneName.value %> is?'
507     end,
508
509     Q::VignetteTwo = Q::Satisfaction.declare_new do
510       text "_<%= Datum::VignetteTwoName.value %> is 33 years old. She got divorced 2 years ago, and during the week
        she looks after her 9-year-old son on her own. <%= Datum::VignetteTwoName.value %> earns £20,000 a
        year in a public sector job. She's in good health, and has a circle of close friends whom she sees
        fairly regularly.."
511       text 'How satisfied with her life as a whole do you think <%= Datum::VignetteTwoName.value %> is?'
512     end,
513
514     Q::VignetteThree = Q::Satisfaction.declare_new do
515       text "_<%= Datum::VignetteThreeName.value %> is 25 years old. He's married, without children, and works full-
        time from home. Between them, he and his wife bring home £40,000 a year. They go out with family or
        friends most weeks. <%= Datum::VignetteThreeName.value %> keeps in good shape, and plays football most
        weekends.."

```

```

516     text 'How satisfied with his life as a whole do you think <%= Datum::VignetteThreeName.value %> is?'
517   end,
518
519   Q::VignetteFour = Q::Satisfaction.declare_new do
520     text "<%= Datum::VignetteFourName.value %> is 58 years old. She's married, with two grown-up children, and
521       works for a large, successful firm. She and her husband have a combined income of £200,000 a year. They
522       entertain or go out with friends once or twice a week, and take several holidays a year. <%= Datum::
523       VignetteFourName.value %> is close to her family, and looks forward to seeing more of her grandchildren
524       when she retires.."
525     text 'How satisfied with her life as a whole do you think <%= Datum::VignetteFourName.value %> is?'
526   end
527 ]
528
529 datum(Datum::VignetteOrder = Datum::Base.declare_new { value (0...vignettes.length).to_a.shuffle unless value })
530 questions(vignettes.values_at(*Datum::VignetteOrder.value))
531
532 progress_weight 2 # because difficult questions
533 end,
534
535 P::EssOne = P::Wellbeing.declare_new do # E4 - E7
536   title 'Wellbeing'
537   text "*Over the next few pages we'll ask some more questions about how you feel about yourself and your life.*
538     Again, there are no right or wrong answers."
539   text "*Some questions may seem a bit similar to each other*, but please bear with us. Try to consider each
540     question in its own right.", :style => :info
541   text 'Please say how much you agree or disagree with each of the following statements.'
542   questions(
543     Q::EssOptimistic = Q::EssAgreement.declare_new { text "I'm always optimistic about my future" },
544     Q::EssPositivity = Q::EssAgreement.declare_new { text 'In general I feel very positive about myself' },
545     Q::EssFailure = Q::EssAgreement.declare_new { text 'At times I feel as if I am a failure' },
546     Q::EssNearlyIdeal = Q::EssAgreement.declare_new { text 'On the whole my life is close to how I would like it to
547       be' }
548   )
549
550 question_separator
551 questions(
552   Q::EssHappy = Q::ScaleHorizontal.declare_new do # ESS C3
553     text 'Taking all things together, how happy would you say you are?'
554     scale :range => 0..10,
555       :start => "Extremely \n unhappy",
556       :end => "Extremely \n happy"
557   end
558 )
559 end,
560
561 P::EssTwo = P::Wellbeing.declare_new do # E8 - E22
562   title '%(small)Wellbeing (2/7)%'
563   text 'Please tell us how much of the time *during the past week*...'
564   questions(
565     Q::EssWeekDepressed = Q::EssTime.declare_new { text '... you felt depressed?' },
566     Q::EssWeekEffort = Q::EssTime.declare_new { text '... you felt that everything you did was an effort?' },
567     Q::EssWeekRestlessSleep = Q::EssTime.declare_new { text '... your sleep was restless?' },
568     Q::EssWeekHappy = Q::EssTime.declare_new { text '... you were happy?' },
569     Q::EssWeekLonely = Q::EssTime.declare_new { text '... you felt lonely?' },
570     Q::EssWeekEnjoyedLife = Q::EssTime.declare_new { text '... you enjoyed life?' },
571     Q::EssWeekSad = Q::EssTime.declare_new { text '... you felt sad?' },
572     Q::EssWeekNotGoing = Q::EssTime.declare_new { text "... you couldn't get going?" }
573   )
574   text 'And please tell us how much of the time *during the past week*...'
575   questions(
576     Q::EssWeekMuchEnergy = Q::EssTime.declare_new { text '... you had a lot of energy?' },
577     Q::EssWeekAnxiety = Q::EssTime.declare_new { text '... you felt anxious?' },
578     Q::EssWeekTired = Q::EssTime.declare_new { text '... you felt tired?' },
579     Q::EssWeekAbsorbed = Q::EssTime.declare_new { text '... you were absorbed in what you were doing?' },
580     Q::EssWeekCalm = Q::EssTime.declare_new { text '... you felt calm and peaceful?' },
581     Q::EssWeekBored = Q::EssTime.declare_new { text '... you felt bored?' },
582     Q::EssWeekRested = Q::EssTime.declare_new { text '... you felt really rested when you woke up in the morning?' }
583   )
584   )
585   progress_weight 2.5
586 end,
587
588 P::EssThree = P::Wellbeing.declare_new do # E23 - E32
589   title '%(small)Wellbeing (3/7)%'
590   text 'To what extent do you agree or disagree with each of the following statements?'
591   questions(
592     Q::EssFreeDecide = Q::EssAgreement.declare_new { text 'I feel I am free to decide for myself how to live my
593       life' },
594     Q::EssSeldomEnjoy = Q::EssAgreement.declare_new { text 'In my daily life, I seldom have time to do the things I
595       really enjoy' },
596     Q::EssNoChanceCapable = Q::EssAgreement.declare_new { text 'In my daily life I get very little chance to show
597       how capable I am' },
598     Q::EssLoveLearning = Q::EssAgreement.declare_new { text 'I love learning new things' },
599     Q::EssAccomplishment = Q::EssAgreement.declare_new { text 'Most days I feel a sense of accomplishment from what
600       I do' },
601     Q::EssLikePlanning = Q::EssAgreement.declare_new { text 'I like planning and preparing for the future' },
602     Q::EssLongTimeNormal = Q::EssAgreement.declare_new { text 'When things go wrong in my life, it generally takes
603       me a long time to get back to normal' },
604     Q::EssPhysicalActivity = Q::EssAgreement.declare_new { text 'My life involves a lot of physical activity' }
605   )
606   progress_weight 1.5

```

```

594     end,
595     P::EssFour = P::Wellbeing.declare_new do # C2 & C3, E33 - E34
596         title '%(small)Wellbeing (4/7)%'
597
598     questions(
599         Q::EssSatisfiedLifeSoFar = Q::Satisfaction.declare_new do
600             text 'How satisfied are you with how your life has turned out so far?'
601             end,
602             Q::EssStandardofLiving = Q::Satisfaction.declare_new do
603                 text 'And how satisfied are you with your present standard of living (material circumstances)?'
604                 end
605             )
606
607     question_separator
608     questions(
609         Q::SocialMeeting = Q::Frequency.declare_new do # ESS C2
610             text 'How often do you meet *socially* with friends, relatives or work colleagues?'
611             end,
612             Q::CloseFriend = Q::YesNo.declare_new do # ESS C3
613                 text 'Do you have anyone with whom you can discuss intimate and personal matters?'
614                 end
615             )
616
617     question_separator
618     text 'How much of the time spent with your immediate family (children, parents, siblings and partner) is...'
619     questions(
620         Q::EssFamilyTimeEnjoyable = Q::EssTimeProportion.declare_new { text '... enjoyable?' }, # ESS E33
621         Q::EssFamilyTimeStressful = Q::EssTimeProportion.declare_new { text '... stressful?' } # ESS E34
622     )
623
624     progress_weight 1.5
625 end,
626 P::EssFive = P::Wellbeing.declare_new do # A8, E35 - E39
627     title '%(small)Wellbeing (5/7)%'
628
629     text 'Please tell us to what extent...'
630     questions(
631         Q::EssChanceToLearn = Q::EssAgreementScale.declare_new { text '... you get a chance to learn new things?' },
632         Q::EssLocalHelp = Q::EssAgreementScale.declare_new { text '... you feel that people in your local area help one another?' },
633         Q::EssRespected = Q::EssAgreementScale.declare_new { text '... you feel that people treat you with respect?' },
634         Q::EssUnfairlyTreated = Q::EssAgreementScale.declare_new { text '... you feel that people treat you unfairly?' },
635         Q::EssRecognition = Q::EssAgreementScale.declare_new { text '... you feel that you get the recognition you deserve for what you do?' }
636     )
637     question_separator
638     questions(
639         Q::EssTrust = Q::ScaleHorizontal.declare_new do # A8
640             text "Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?"
641             scale :range => 0..10,
642                 :start => "You can't be \n too careful",
643                 :end => "Most people \n can be trusted"
644         end
645     )
646 end,
647
648 P::EssSix = P::Wellbeing.declare_new do # E40 - E47
649     title '%(small)Wellbeing (6/7)%'
650
651     text 'Please say to what extent you agree or disagree with each of the following statements.'
652     questions(
653         Q::EssDoValuable = Q::EssAgreement.declare_new { text 'I generally feel that what I do in my life is valuable and worthwhile' },
654         Q::EssHelpReturned = Q::EssAgreement.declare_new { text 'If I help someone I expect some help in return' },
655         Q::EssNowWorldHope = Q::EssAgreement.declare_new { text 'The way things are now, I find it hard to be hopeful about the future of the world' },
656         Q::EssCaredFor = Q::EssAgreement.declare_new { text 'There are people in my life who really care about me' },
657         Q::EssBritainWorse = Q::EssAgreement.declare_new { text 'For most people in Britain, life is getting worse rather than better' },
658         Q::EssCloseLocal = Q::EssAgreement.declare_new { text 'I feel close to the people in my local area' },
659     )
660     question_separator
661     question(
662         Q::EssTooMuchTelly = Q::Radio.declare_new do # ESS E46
663             text 'Do you ever feel frustrated by having watched too much television?'
664             options [1, 'Yes, often'],
665                 [2, 'Yes, sometimes'],
666                 [3, 'Occasionally'],
667                 [4, 'No, never']
668             option_separator
669             option [5, 'Never watch TV']
670         end
671     )
672     question_separator
673     questions(
674         Q::EssRoutingWork = Q::YesNo.declare_new do
675             text 'Are you currently in paid work of any kind?'
676             end,
677             Q::EssRoutingWorkAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::EssRoutingWork }

```

```

678     )
679   end,
680
681   P::EssSeven = P::Wellbeing.declare_new do
682     title '%(small)Wellbeing (7/7)%'
683
684   questions(
685     Q::EssJobSatisfaction = Q::EssSatisfaction.declare_new do # E48
686       text 'All things considered, how satisfied are you with your present job?'
687       text 'If you have more than one job, please answer about your main job.', :style => :smaller
688     end,
689     Q::EssWorkLifeBalance = Q::EssSatisfaction.declare_new do # E49
690       text 'How satisfied are you with the balance between the time you spend on your paid work and the time you
691       spend on other aspects of your life?'
692     end
693   )
694
695   question_separator
696   text 'How much of the time do you find your job...'
697   questions(
698     Q::EssJobInteresting = Q::EssTimeProportionNoNa.declare_new { text '... interesting?' }, # ESS E50
699     Q::EssJobStressful = Q::EssTimeProportionNoNa.declare_new { text '... stressful?' } # ESS E51
700   )
701
702   question_separator
703   questions(
704     Q::EssUnemploymentLikelihood = Q::Radio.declare_new do # ESS E52
705       text 'How likely would you say it is that you will become unemployed in the next 12 months?'
706       options [1, 'Very likely'],
707                 [2, 'Likely'],
708                 [3, 'Not very likely'],
709                 [4, 'Not at all likely']
710     end
711   )
712
713   text 'To what extent do you agree or disagree with the following statement?'
714   question(
715     Q::EssPaidAppropriately = Q::EssAgreement.declare_new do # ESS E53
716       # 'enough' might be less ambiguous than 'appropriately' here -- for people who feel like they're overpaid!
717       text 'Considering all my efforts and achievements in my job, I feel I get paid appropriately.'
718     end
719   )
720
721   questions(
722     Q::EssCompareImpt = Q::EssImportance.declare_new { text "How important is it for you to compare your income
723       with other people's incomes?" }, # ESS E54
724     Q::EssComparisonGroup = Q::Radio.declare_new do # ESS E55
725       text 'Whose income would you be *most* likely to compare your own with?'
726       options [1, 'Work colleagues'],
727                 [2, 'Family members'],
728                 [3, 'Friends'],
729                 [4, 'Others']
730     end
731   )
732
733   progress_weight 2
734 end,
735 skip_unless { Q::EssRoutingWork.answer == 1 },
736 P::NatureRelatedness = P::Wellbeing.declare_new do
737   title 'Nature relatedness'
738   text "*Thanks--you've finished the section on wellbeing.* The remainder of the survey is about a wide range of
739   other topics.", :style => :info
740   # this is the Nature Relatedness scale, Nisbet et al 2008, NR-Self and NR-Experience (but excluding NR-
741   Perspective)
742
743   text "Please rate the extent to which you agree with each of these statements. There are no right or wrong
744   answers."
745   questions(
746     Q::NatRelEnjoyOutdoors = Q::EssAgreement.declare_new { text 'I enjoy being outdoors, even in unpleasant weather
747       ' },
748     # Q::NatRelSpeciesToDie = Q::EssAgreement.declare_new { text 'Some species are just meant to die out or become
749       extinct' },
750     # Q::NatRelNaturalResourceRights = Q::EssAgreement.declare_new { text 'Humans have the right to use natural
751       resources any way we want' },
752     Q::NatRelWildVacation = Q::EssAgreement.declare_new { text 'My ideal vacation spot would be a remote,
753       wilderness area' },
754     Q::NatRelThinkEnvironment = Q::EssAgreement.declare_new { text 'I always think about how my actions affect the
755       environment' },
756     Q::NatRelDigger = Q::EssAgreement.declare_new { text 'I enjoy digging in the earth and getting dirt on my hands
757       ' },
758     Q::NatRelSpiritualPart = Q::EssAgreement.declare_new { text 'My connection to nature and the environment is a
759       part of my spirituality' },
760     Q::NatRelEnvAware = Q::EssAgreement.declare_new { text 'I am very aware of environmental issues' },
761     Q::NatRelNoticeWildlife = Q::EssAgreement.declare_new { text 'I take notice of wildlife wherever I am' },
762     Q::NatRelRarelyInNature = Q::EssAgreement.declare_new { text 'I don't often go out in nature' },
763     # Q::NatRelNoActionHelps = Q::EssAgreement.declare_new { text 'Nothing I do will change problems in other
764       places on the planet' },
765     Q::NatRelNotSeparate = Q::EssAgreement.declare_new { text 'I am not separate from nature, but a part of nature'
766       },

```

```

755     Q::NatRelWoodsScary = Q::EssAgreement.declare_new { text 'The thought of being deep in the woods, away from
756         civilization, is frightening' },
757     Q::NatRelNatureNoEffect = Q::EssAgreement.declare_new { text 'My feelings about nature do not affect how I live
758         my life' },
759     # Q::NatRelNoAnimalRights = Q::EssAgreement.declare_new { text 'Animals, birds and plants should have fewer
760         rights than humans' },
761     Q::NatRelNoticeCityNature = Q::EssAgreement.declare_new { text 'Even in the middle of the city, I notice nature
762         around me' },
763     Q::NatRelIdentity = Q::EssAgreement.declare_new { text 'My relationship to nature is an important part of who I
764         am' },
765     # Q::NatRelNoConservation = Q::EssAgreement.declare_new { text 'Conservation is unnecessary because nature is
766         strong enough to recover from any human impact' },
767     # Q::NatRelAnimalsPredict = Q::EssAgreement.declare_new { text 'The state of non-human species is an indicator
768         of the future for humans' },
769     Q::NatRelThinkSuffering = Q::EssAgreement.declare_new { text 'I think a lot about the suffering of animals' },
770     Q::NatRelConnectedness = Q::EssAgreement.declare_new { text 'I feel very connected to all living things and the
771         earth' }
772   )
773
774   progress_weight 3
775 end,
776
777 P::HealthLifestyle = P::Wellbeing.declare_new do
778   title 'Health and lifestyle'
779
780   questions(
781     Q::SelfReportedHealth = Q::Radio.declare_new do
782       text 'How is your health in general?'
783       options [4, 'Very good'],
784           [3, 'Good'],
785           [2, 'Fair'],
786           [1, 'Bad'],
787           [0, 'Very bad']
788     end
789   )
790
791   question_separator
792   questions(
793     Q::Asthma = Q::YesNo.declare_new do
794       text 'Have you ever been told by a doctor that you have asthma?'
795     end,
796
797     Q::Cardiovascular = Q::YesNo.declare_new do
798       text 'Have you ever been told by a doctor that you have a heart or lung disease?'
799     end,
800
801     Q::SmokeAtAll = Q::YesNo.declare_new do
802       # BHPS 2006
803       text 'Do you ever smoke cigarettes?'
804     end,
805
806     Q::SmokeAtAllAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::SmokeAtAll },
807
808     Q::SmokeNumber = Q::Radio.declare_new do
809       # BHPS 2006 -- except original question asked to enter actual number
810       show_if :condition => -> { Q::SmokeAtAll.answer == 1 },
811         :js_condition => "return <%= Q::SmokeAtAll.js_instance %>.answer() == 1;",
812         :human_condition => "Please complete this question only if you answered 'Yes' above."
813       text 'How many cigarettes a day do you usually smoke, including those you roll yourself?'
814       options [1, 'Fewer than 1 a day'],
815           [2, '1 - 5 a day'],
816           [5, '5 - 14 a day'],
817           [15, '15 - 24 a day'],
818           [25, '25 a day or more']
819     end
820   )
821
822   question_separator
823   questions(
824     Q::Alcohol = Q::Frequency.declare_new do
825       # # Scottish Health Survey 1998 -- but adapted frequencies
826       # text 'How often do you usually have an alcoholic drink?'
827     end,
828
829     Q::FruitVeg = Q::Radio.declare_new do
830       # Guidance from http://www.5aday.nhs.uk/
831       text 'How many portions of fruit and vegetables do you usually eat a day?'
832       text "Please do *not* count potatoes or grains. In Please *do* count pure juices, tinned, frozen and dried
833         fruit and vegetables, and fruit and vegetables found in other foods.", :style => :smaller
834       options [0, 'Fewer than 1 a day'],
835           [2, '1 - 2 a day'],
836           [4, '3 - 4 a day'],
837           [5, '5 a day or more']
838     end,
839
840     Q::Fish = Q::Frequency.declare_new do
841       text 'And how often do you usually eat fish or shellfish?'
842     end
843   )
844
845   question_separator

```

```

837 questions(
838   Q::SleepLastNight = Q::SleepHours.declare_new do
839     text 'How much sleep did you get in the *past 24 hours*, to the nearest half hour?'
840   end,
841
842   Q::SleepGot = Q::SleepHours.declare_new do
843     text 'How much sleep do you estimate that you *typically* get, per day?'
844   end
845 )
846
847 progress_weight 2
848 end,
849
850 P::HomeBasics = P::Wellbeing.declare_new do
851   title 'Your home'
852
853   text "*You're over halfway through the survey.* We really appreciate your help.", :style => :info
854
855   text 'These questions are about the place where you usually live.'
856
857   # questions mainly from/adapted from Survey of English Housing 2004/05
858
859 questions(
860   Q::AccommType = Q::Radio.declare_new do
861     text "Is your household's accommodation..."
862     options [:house, "a house or bungalow"],
863       [:flat, "a flat or maisonette"],
864       [:room, "a room (or rooms)"],
865       [:other, "or something else?"]
866   end,
867
868   Q::HouseType = Q::Radio.declare_new do
869     show_if :condition => -> { Q::AccommType.answer == :house },
870       :js_condition => "return <%= Q::AccommType.js_instance %>.answer() == 'house';",
871       :human_condition => "Please complete this question only if you answered 'house or bungalow' above."
872
873     text 'Is the house or bungalow...'
874     options [:detached, "detached"],
875       [:semi, "semi-detached"],
876       [:terraced, "or terraced (including end-of-terrace)?"]
877   end,
878
879   Q::FlatType = Q::Radio.declare_new do
880     show_if :condition => -> { Q::AccommType.answer == :flat },
881       :js_condition => "return <%= Q::AccommType.js_instance %>.answer() == 'flat';",
882       :human_condition => "Please complete this question only if you answered 'flat or maisonette' above."
883
884     text 'Is the flat or maisonette...'
885     options [:block, "in a purpose-built block"],
886       [:conversion, "or in a converted house (or other kind of building)?"]
887   end,
888
889   Q::OtherType = Q::Radio.declare_new do
890     show_if :condition => -> { Q::AccommType.answer == :other },
891       :js_condition => "return <%= Q::AccommType.js_instance %>.answer() == 'other';",
892       :human_condition => "Please complete this question only if you answered 'something else' above."
893
894     text 'Is the accommodation...'
895     options [:mobile, "a caravan, mobile home or houseboat"],
896       [:other, "or some other kind of accommodation?"]
897   end,
898
899   Q::Tenure = Q::Radio.declare_new do
900   # Question (but not options) from Scottish House Condition Survey 1996, Q18
901
902   text 'Which of these best describes your tenure here?'
903   options [:own, 'Own outright'],
904     [:mortgage, 'Buying with the help of a mortgage or loan'],
905     [:rent, 'Rent'],
906     [:shared, 'Pay part rent and part mortgage (shared ownership)'],
907     [:rent_free, "Live rent-free (excluding squatting)"],
908     [:squat, 'Squatting'],
909     [:other, 'Other arrangement']
910 end,
911
912   Q::Landlord = Q::Radio.declare_new do
913     show_if :condition => -> { [:rent, :shared].include?(Q::Tenure.answer) },
914       :js_condition => "var a = <%= Q::Tenure.js_instance %>.answer(); return a == 'rent' || a == 'shared';",
915       :human_condition => "Please complete this question only if you answered 'Rent' or 'Pay part rent and part mortgage' above."
916
917   text 'Who is your landlord?'
918   options [:council, 'The local authority (council) or New Town Development'],
919     [:ha, 'A housing association, co-operative, charitable trust or Local Housing Company'],
920     [:other, 'Any other individual or organisation']
921 end,
922
923   Q::YearsLivedHere = Q::Radio.declare_new do
924     text 'How long have you lived in this accommodation?'
925     options [0, 'Less than 12 months'],

```

```

926 [1, '12 months but less than 2 years'],
927 [2, '2 years but less than 5 years'],
928 [5, '5 years but less than 10 years'],
929 [10, '10 years but less than 20 years'],
930 [20, '20 years or longer']
931 end,
932
933 Q::WhereBefore = Q::Radio.declare_new do
934   text 'And where did you live just before you moved to this accommodation?'
935   options [:london, 'Greater London'],
936     [:city, 'Another big city (population: over 1 million)'],
937     [:big_town, 'A city or large town (population: 100,000 - 1 million)'],
938     [:town, 'A town (population: 10,000 - 100,000)'],
939     [:village, 'A village or hamlet (population: under 10,000)'],
940     [:rural, 'The countryside']
941   option_separator
942   option [:nowhere, "I've always lived in this accommodation"]
943 end
944 )
945 progress_weight 2
946 end,
947 P::HomeDetails = P::Wellbeing.declare_new do
948   title 'Inside your home'
949
950 # household definition from
951 # http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/householdestimates/
952   notesdefinitions/
953
954   text "In this survey, a *household* means:
955
956   * one person living alone, or
957   * a group of people living at the same address who share common housekeeping or a living room.", :style => :info
958
959   questions(
960     Q::HouseholdSixteenPlus = Q::Dropdown.declare_new do
961       text 'How many adults (aged 16 or over) live in your household?'
962       text "Please *include yourself* if you're aged 16 or over.", :style => :smaller
963       options integer_scale 1..9
964       option [10, '10 or more']
965     end,
966
967     Q::HouseholdUnderSixteen = Q::Dropdown.declare_new do
968       text 'And how many children (aged 15 or under) live in your household?'
969       text "Please *include yourself* if you're aged 15 or under.", :style => :smaller
970       option [0, 'None']
971       options integer_scale 1..9
972       option [10, '10 or more']
973     end,
974
975     Q::HouseholdRooms = Q::Dropdown.declare_new do
976       text 'How many rooms does your household have the use of, not counting bathrooms and toilets?'
977       options integer_scale 1..9
978       option [10, '10 or more']
979     end,
980
981     Q::LivingFloor = Q::Radio.declare_new do
982       text 'On what floor of the building as a whole is your main living space?'
983       text 'If your main living space is on more than one floor, please choose the highest.', :style => :smaller
984       options [-1, 'Basement or semi-basement'],
985         [0, 'Ground floor (street level)'],
986         [1, '1st floor'],
987         [2, '2nd floor'],
988         [3, '3rd floor'],
989         [4, '4th - 9th floor'],
990         [10, '10th floor or higher']
991     end,
992
993     Q::DoubleGlazing = Q::Radio.declare_new do
994       # adapted from SoEH04/5
995       text 'Do you have double glazing?'
996       text 'Please count only factory-made sealed units.', :style => :smaller
997       options [:all, 'Yes--in all windows'],
998         [:some, 'Yes--in some windows, but not all'],
999         [:none, 'No--none']
1000   end,
1001
1002   Q::HousingProblems = Q::Checkbox.declare_new do
1003     text 'Does your home have any of the following problems?'
1004     text "Please tick *all* that apply.", :style => :smaller
1005     options [:mould, 'Mould growth (at least hand-sized patches) on walls or carpets'],
1006       [:cold, "Heating that doesn't keep you warm enough in winter"],
1007       [:draughts, 'Serious draughts due to poorly fitting windows or doors'],
1008       [:insects, 'Insect infestation (e.g. moths, cockroaches, bedbugs or fleas)'],
1009       [:gloom, 'Lack of natural light']
1010     option_separator
1011     exclusive_option [:none, 'None of the above']
1012   end
1013 )
1014 end,
1015 P::HomePostcode = P::Wellbeing.declare_new do

```

```

1016 title 'Home postcode'
1017
1018 text "*We ask this question so we can work out environmental conditions--things such as levels of air pollution,
      noise, and distance to green spaces--around where you live. \n\n *Please be assured that your information
      is confidential and secure* (click '<%= help_page[:text] %>', above right, to find out more).", :style => :
      info
1019
1020 questions(
1021   Q::JavascriptEnabled,
1022
1023   Q::HomePostcode = Q::BorderlessPostcode.declare_new do
1024
1025     text "What is your full home postcode?"
1026     completion -> { Q::HomePostcodeUnknown.answer.blank? ? :prompted : :optional }
1027     prompted_completion_message "*You don't have to give your postcode, but we'd really appreciate it if you did,
      since location characteristics are key to our research.* \n\n If you don't know your postcode, please
      tick the box below and enter the name of your street and town/city instead."
1028   end,
1029
1030   Q::HomePostcodeUnknown = Q::UnclearedCheckbox.declare_new do
1031     option [:dk, "I don't know my postcode"]
1032     no_next_prompt
1033     completion :optional
1034   end,
1035
1036   Q::HomeStreetName = Q::Text.declare_new do
1037     show_if :condition => -> { a = Q::HomePostcodeUnknown.answer; a && a.length > 0 },
1038     :js_condition => "var a = <%= Q::HomePostcodeUnknown.js_instance %>.answer(); return a && a.length >
      0;",
1039     :human_condition => "Please complete this question only if you ticked 'I don't know my postcode'
      above."
1040
1041     text 'What are your street and city or town?'
1042     text "Please write *Street, City* (separated with a comma).", :style => :smaller
1043     text_box :size => '30x1', :default_text => 'e.g. Downing Street, London'
1044
1045     completion -> { Q::HomePostcodeUnknown.answer.blank? ? :optional : :prompted }
1046     prompted_completion_message "You don't have to give your street and town, but we would really appreciate it
      if you did, since location characteristics are key to our research."
1047   end
1048 )
1049
1050 local_js %q{
1051   document.observe('dom:loaded', function() {
1052     var disenable = function() { <%= Q::HomePostcode.js_instance %>.set_enabled(<%= Q::HomePostcodeUnknown.
      js_instance %>.blank()); }
1053     $A(['click', 'keypress']).each(function(e) { document.observe(e, disenable) });
1054     disenable(); // also do it now
1055   });
1056 }
1057
1058 progress_weight 0.5
1059 end,
1060
1061 P::HomeMapLocation = P::Wellbeing.declare_new do
1062   title 'Your home on the map'
1063
1064   has_postcode = Q::HomePostcode.answer &&
1065     (Q::HomePostcode.answer.length > 6 || (Q::HomePostcode.answer.length > 1 && Q::HomeStreetName.
      answer.blank?))
1066
1067   text "*We ask this question to help us work out environmental conditions as accurately as possible*, since two
      buildings #has_postcode ? 'with the same postcode could be on different streets' : 'on the same street
      could be a long distance apart', with different levels of traffic, noise, and so on. \n\n *Please be
      assured that your information is confidential and secure* (click '<%= help_page[:text] %>', above right, to
      find out more).", :style => :info
1068
1069 questions(
1070   Q::HomeMapLocation = Q::VirtualEarth.declare_new do
1071
1072     depends_on Q::HomePostcode
1073
1074     text "Many thanks for providing your #{has_postcode ? 'postcode' : 'street and city'}. Based on this, the
      satellite map below should show the neighbourhood around your home."
1075
1076     text "*Please click and drag to move the map so that your home is in the centre, inside the yellow box.*#{
      *(If a list of possible locations is shown, first select a location from the list.)*' unless
      has_postcode}"
1077
1078     map :start_location => has_postcode ?
1079       Q::HomePostcode.answer + ', UK' :
1080       (Q::HomeStreetName.answer ? Q::HomeStreetName.answer + ', UK' : nil)
1081
1082     revealed_text :show_label => 'Show help using the map &#187;',
1083     :hide_label => '&#171; Hide help',
1084     :text => %Q{*Trouble finding your home?* \n\n If you can't find your home on the map displayed
      here, please zoom out a few levels to get your bearings, then zoom back in on your home
      location. \n\n *Map controls* \n\n _Zoom in_: use the + button at the top left of the map,
      or double click on the point you wish to zoom in on. \n\n _Zoom out_: use the - button at
      the top left of the map. \n\n _Move the map view_: click on the map, keeping the mouse
      button held down; drag the map to a new location by moving your mouse; and release the

```

```

mouse button. \n\n }
1085 end,
1086
1087 Q::HomeMapStatus = Q::Radio.declare_new do
1088   text 'How did you get on?'
1089   options [:confirmed, "My home is in the yellow box"],
1090     [:approximate, "My home is in or near the yellow box--it could be one or two buildings either way"],
1091     [:not_found, "I couldn't find my home on the map"],
1092     [:not_working, "The map didn't load/didn't work"],
1093     [:refused, "I prefer not to say exactly where I live"]
1094   end
1095 )
1096 end,
1097 skip_unless {
1098   Q::JavascriptEnabled.answer == 'yes' && (
1099     (Q::HomePostcode.answer && Q::HomePostcode.answer.length > 1) || ! Q::HomeStreetName.answer.blank?
1100   )
1101 },
1102 P::LocalArea = P::Wellbeing.declare_new do
1103   title 'Your neighbourhood'
1104
1105   questions(
1106     Q::SatArea = Q::Satisfaction.declare_new do
1107       text 'How satisfied are you with the area in which you live?'
1108     end,
1109     Q::SafetyAfterDark = Q::Radio.declare_new do
1110       # ESS C6 -- options from BCS 06/07
1111       text 'How safe do you -- or would you -- feel walking alone in this area after dark?'
1112       options [1, 'Very safe'],
1113         [2, 'Fairly safe'],
1114         [3, 'A bit unsafe'],
1115         [4, 'Very unsafe']
1116     end,
1117     Q::Neighbours = Q::Frequency.declare_new do
1118       text "How often do you usually speak to your neighbours?"
1119     end
1120   )
1121
1122 if (! Q::HomePostcode.answer || Q::HomePostcode.answer.length < 3) && (! Q::HomeStreetName.answer || Q::
1123   HomeStreetName.answer.length < 3)
1124   question(
1125     Q::HomeNearestStation = Q::Text.declare_new do
1126       text "What's your nearest tube or railway station?"
1127       text_box :size => '30x1'
1128     end
1129   end
1130
1131   question_separator
1132   text 'Below are some things that can cause problems for people in their area. Which of these are problems in the
1133   area where you live?'
1134   questions(
1135     # list adapted from Survey of English Housing 04/05 and BCS 06/07
1136     Q::AirPollution = Q::ScaleOfProblem.declare_new { text 'Air pollution' },
1137     Q::RoadRailNoise = Q::ScaleOfProblem.declare_new { text 'Noise from road traffic and trains' },
1138     Q::AircraftNoise = Q::ScaleOfProblem.declare_new { text 'Noise from aircraft' },
1139     Q::NeighbourNoise = Q::ScaleOfProblem.declare_new { text 'Noisy neighbours or loud parties' },
1140     Q::Litter = Q::ScaleOfProblem.declare_new { text 'Rubbish or litter lying around' },
1141     Q::Vandalism = Q::ScaleOfProblem.declare_new { text 'Vandalism or graffiti' },
1142     Q::Crime = Q::ScaleOfProblem.declare_new { text 'Crime' }
1143   )
1144   progress_weight 2
1145 end,
1146
1147 P::GreenSpace = P::Wellbeing.declare_new do
1148   title 'Green space'
1149
1150   # some questions adapted from Survey of Public Attitudes toward the Environment 2007 (ESRC QB)
1151   questions(
1152     Q::Garden = Q::Radio.declare_new do
1153       text 'Do you have a garden?'
1154       options [:own, 'Yes--own garden'],
1155         [:shared, 'Yes--shared with others'],
1156         [:none, 'No']
1157     end,
1158
1159     Q::GardenAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::Garden },
1160
1161     Q::GardenUse = Q::Frequency.declare_new do
1162       show_if :condition => -> { [:own, :shared].include?(Q::Garden.answer) },
1163       :js_condition => "return $A(['own', 'shared']).include(<%= Q::Garden.js_instance %>.answer());",
1164       :human_condition => "Please complete this question only if you answered 'Yes' above."
1165
1166       text 'During the summer, how often do you spend time in the garden?'
1167     end,
1168
1169     Q::Allotment = Q::YesNo.declare_new do
1170       text 'Do you have an allotment?'
1171     end,
1172

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```

1173 Q::AllotmentAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::Allotment },
1174
1175 Q::AllotmentVisits = Q::Frequency.declare_new do
1176   show_if :condition => -> { Q::Allotment.answer == 1 },
1177   :js_condition => "return <%= Q::Allotment.js_instance %>.answer() == 1;",
1178   :human_condition => "Please complete this question only if you answered 'Yes' above."
1179
1180   text 'During the summer, how often do you spend time at the allotment?'
1181   end
1182 )
1183
1184 question_separator
1185 questions(
1186   Q::GreenSpaceAccess = Q::Radio.declare_new do
1187     text 'How well provided would you say your local area is with public parks, gardens, commons, and other
1188       public recreational green spaces?'
1189     text 'Please consider the *number*, *size* and *quality* of these spaces.', :style => :smaller
1190     options [5, 'Very well'],
1191       [4, 'Well'],
1192       [3, 'Adequately'],
1193       [2, 'Poorly'],
1194       [1, 'Very poorly']
1195   end,
1196
1196 Q::GreenSpaceVisits = Q::Frequency.declare_new do
1197   text 'During the summer, how often do you visit these kinds of green spaces for leisure?'
1198   text "Please *don't count* occasions when you only pass through on your way to somewhere else.", :style => :
1199     smaller
1200   end,
1201
1202   # add golf courses?
1202   # add purpose of visits? e.g. (dog) walking, running, cycling, other sports and games, picnicking, looking
1202     after children
1203
1204 Q::GreenSpacePassing = Q::Frequency.declare_new do
1205   text 'And how often do you walk or cycle through these kinds of green spaces on your way to somewhere else?'
1206 end
1207 )
1208
1209 question_separator
1210 questions(
1211   Q::CountrysideVisits = Q::Frequency.declare_new do
1212     text 'During the summer, how often do you visit open countryside for leisure?'
1213   end
1214
1215   # add purpose of visits? e.g. (dog) walking, running, cycling/mountain biking, climbing, other sports and games
1215     , picnicking, birdwatching, fishing, hunting, drawing/painting, foraging, other ...
1216 )
1217
1218 question_separator
1219 questions(
1220   Q::HomeGreenViewshed = Q::Checkbox.declare_new do
1221     text 'Which of the following can you see from *any* of the windows in your home?'
1222     text 'Please tick *all* that apply.', :style => :smaller
1223     options [:trees, 'Trees'],
1223       [:privaterec, 'Private recreational green space (e.g. gardens or allotments)'],
1225       [:publicrec, 'Public recreational green space (e.g. parks)'],
1226       [:nonrec, 'Other green space']
1227     option_separator
1228     exclusive_option [:none, 'None of the above']
1229   end
1230 )
1231
1232 progress_weight 2
1233 end,
1234
1235 P::OtherPlace = P::Wellbeing.declare_new do
1236   title 'Other location'
1237
1238   questions(
1239     Q::OtherPlaceType = Q::Radio.declare_new do
1240       text 'Apart from your home, in what single location do you spend most time?'
1241       options [:work, 'Workplace'],
1242         [:study, 'Place of study'],
1243         [:other, 'Other location']
1244       option_separator
1245       option [:none, 'No single location']
1246     end,
1247
1248     Q::OtherPlaceTypeAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::OtherPlaceType },
1249
1250     Q::OtherPlaceOther = Q::Text.declare_new do
1251       show_if :condition => -> { Q::OtherPlaceType.answer == :other },
1252       :js_condition => "return <%= Q::OtherPlaceType.js_instance %>.answer() == 'other';",
1253       :human_condition => "Please complete this question only if you answered 'Other location' above."
1254
1255       text 'What is this other location?'
1256       text_box :size => '30x1'
1257     end
1258   )
1259

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```

1260     progress_weight 0.5
1261   end,
1262
1263   P:::OtherPlacePostcode = P:::Wellbeing.declare_new do
1264
1265     place_descriptor = case Q:::OtherPlaceType.answer
1266       when :work then 'workplace'
1267       when :study then 'place of study'
1268       else           'other location'
1269     end
1270
1271     title "#{place_descriptor.humanize} postcode"
1272
1273     text "*We ask this question so we can work out environmental conditions--things such as levels of air pollution,
1274       noise, and distance to green spaces--around your #{place_descriptor}. \n\n *Please be assured that your
1275       information is confidential and secure* (click '<%= help_page[:text] %>', above right, to find out more).",
1276       :style => :info
1277
1278   questions(
1279     Q:::OtherPostcode = Q:::BorderlessPostcode.declare_new do
1280
1281       text "What is the full postcode of your #{place_descriptor}?"
1282
1283       completion -> { Q:::OtherPostcodeUnknown.answer.blank? ? :prompted : :optional }
1284       prompted_completion_message "You don't have to give a postcode here, but we'd really appreciate it if you did
1285         , since location characteristics are key to our research. \n\n If you don't know the postcode, please
1286         tick the box below and enter the name of the street and town/city instead."
1287     end,
1288
1289     Q:::OtherPostcodeUnknown = Q:::UnclearedCheckbox.declare_new do
1290       option [:dk, "I don't know the postcode"]
1291       no_next_prompt
1292       completion :optional
1293     end,
1294
1295     Q:::OtherStreetName = Q:::Text.declare_new do
1296       show_if :condition => -> { a = Q:::OtherPostcodeUnknown.answer; a && a.length > 0 },
1297         :js_condition => "a = <%= Q:::OtherPostcodeUnknown.js_instance %>.answer(); return a && a.length > 0;"
1298
1299       :human_condition => "Please complete this question only if you ticked 'I don't know my postcode'
1300         above."
1301
1302   )
1303
1304   local_js %q{
1305     document.observe('dom:loaded', function() {
1306       var disenable = function() { <%= Q:::OtherPostcode.js_instance %>.set_enabled(<%= Q:::OtherPostcodeUnknown.
1307         js_instance %>.blank()); }
1308       $A(['click', 'keypress']).each(function(e) { document.observe(e, disenable) });
1309       disenable(); // also do it now
1310     });
1311
1312     progress_weight 0.5
1313   end,
1314   skip_unless {
1315     Q:::OtherPlaceType.answer && Q:::OtherPlaceType.answer != :none
1316   },
1317   P:::OtherMapLocation = P:::Wellbeing.declare_new do
1318
1319     place_descriptor = case Q:::OtherPlaceType.answer
1320       when :work then 'workplace'
1321       when :study then 'place of study'
1322       else           'other location'
1323     end
1324     has_postcode = Q:::OtherPostcode.answer &&
1325       (Q:::OtherPostcode.answer.length > 6 || (Q:::OtherPostcode.answer.length > 1 && Q:::OtherStreetName.
1326         answer.blank?))
1327
1328     title "Your #{place_descriptor} on the map"
1329
1330     text "*We ask this question to help us work out environmental conditions as accurately as possible*, since two
1331       buildings #has_postcode ? 'with the same postcode could be on different streets' : 'on the same street
1332       could be a long distance apart', with different levels of traffic, noise, and so on. \n\n *Please be
1333       assured that your information is confidential and secure* (click '<%= help_page[:text] %>', above right, to
1334       find out more).", :style => :info
1335
1336   questions(
1337     Q:::OtherMapLocation = Q:::VirtualEarth.declare_new do
1338
1339       depends_on Q:::OtherPostcode

```

```

1336     text "Many thanks for providing the #{has_postcode ? 'postcode' : 'street and city'}. Based on this, the
1337     satellite map below should show the neighbourhood around your #{place_descriptor}.""
1338
1339     text "*Please click and drag to move the map so that your #{place_descriptor} is in the centre, inside the
1340     yellow box.*#{' *(If a list of possible locations is shown, first select a location from the list.)*' unless has_postcode}"
1341
1342     map :start_location => has_postcode ?
1343         Q::OtherPostcode.answer + ', UK' :
1344         (Q::OtherStreetName.answer ? Q::OtherStreetName.answer + ', UK' : nil)
1345
1346     revealed_text :show_label => 'Show help using the map &#187;',
1347     :hide_label => '&#171; Hide help',
1348     :text => %Q{*Trouble finding the right location?* \n\n If you can't find the right location on
1349     the map displayed here, please zoom out a few levels to get your bearings, then zoom back
1350     in on the right location. \n\n *Map controls* \n\n _Zoom in_: use the + button at the top
1351     left of the map, or double click on the point you wish to zoom in on. \n\n _Zoom out_: use
1352     the - button at the top left of the map. \n\n _Move the map view_: click on the map,
1353     keeping the mouse button held down; drag the map to a new location by moving your mouse;
1354     and release the mouse button. \n\n }
1355
1356   end,
1357
1358
1359   Q::OtherMapStatus = Q::Radio.declare_new do
1360     text 'How did you get on?'
1361     options [:confirmed, "My #{place_descriptor} is in the yellow box"],
1362       [:approximate, "My #{place_descriptor} is in or near the yellow box--it could be one or two buildings
1363       either way"]
1364     #option_separator
1365     options [:not_found, "I couldn't find my #{place_descriptor} on the map"],
1366       [:not_working, "The map didn't load/didn't work"],
1367       [:refused, "I prefer not to say exactly where my #{place_descriptor} is"]
1368   end
1369
1370 )
1371
1372 progress_weight 0.5
1373 end,
1374 skip_unless {
1375   Q::JavascriptEnabled.answer == 'yes' &&
1376     Q::OtherPlaceType.answer && Q::OtherPlaceType.answer != :none &&
1377     (Q::OtherPostcode.answer && Q::OtherPostcode.answer.length > 1) || ! Q::OtherStreetName.answer.blank?
1378 }
1379
1380 P::OtherPlaceDetails = P::Wellbeing.declare_new do
1381
1382   place_descriptor = case Q::OtherPlaceType.answer
1383     when :work then 'workplace'
1384     when :study then 'place of study'
1385     else          'other location'
1386   end
1387
1388   title "#{place_descriptor.humanize} details"
1389
1390   questions(
1391     Q::CommuteTime = Q::Radio.declare_new do
1392       text "About how much time does it usually take for you to get to your #{place_descriptor} each day, door to
1393       door?"
1394       options [5, 'Less than 15 minutes'],
1395         [20, '15 - 29 minutes'],
1396         [40, '30 - 44 minutes'],
1397         [60, '45 - 59 minutes'],
1398         [80, 'An hour or more']
1399   end,
1400   Q::CommuteMeans = Q::Checkbox.declare_new do
1401     text "Which of these means of transport do you usually use to travel to and from your #{place_descriptor}?"
1402     text 'Please tick *all* that apply.', :style => :smaller
1403     options [:rail, 'Train (above ground)'],
1404       [:tube, 'Underground train (tube, metro)'],
1405       [:bus, 'Bus, minibus or coach (public or private)'],
1406       [:bike, 'Motorcycle, scooter or moped'],
1407       [:driver, 'Driving a car or van'],
1408       [:driven, 'Passenger in a car, van or taxi'],
1409       [:bike, 'Bicycle'],
1410       [:walk, 'Walking (or running) _for at least 5 minutes_']
1411     option_separator
1412     exclusive_option [:none, 'None of the above']
1413   end
1414 )
1415
1416 if (! Q::OtherPostcode.answer || Q::OtherPostcode.answer.length < 3) && (! Q::OtherStreetName.answer || Q::
1417   OtherStreetName.answer.length < 3)
1418 question(
1419   Q::OtherNearestStation = Q::Text.declare_new do
1420     text "What's the nearest tube or railway station to your #{place_descriptor}?"
1421     text_box :size => '30x1'
1422   end
1423 )
1424 end

```

```

1415     question_separator
1416     questions(
1417       Q::OtherPlaceFloor = Q::Radio.declare_new do
1418         text "On what floor of the building as a whole do you spend most time in your #{place_descriptor}?"
1419         options [-1, 'Basement or semi-basement'],
1420           [0, 'Ground floor (street level)'],
1421           [1, '1st floor'],
1422           [2, '2nd floor'],
1423           [3, '3rd floor'],
1424           [4, '4th - 9th floor'],
1425           [10, '10th floor or higher']
1426         option_separator
1427         option [:na, 'No single floor']
1428       end,
1429
1430       Q::OtherGreenViewshed = Q::Checkbox.declare_new do
1431         text "Which of the following can you usually see from inside your #{place_descriptor}?"
1432         text 'Please tick *all* that apply.', :style => :smaller
1433         options [:trees, 'Trees'],
1434           [:privaterec, 'Private recreational green space (e.g. gardens or allotments)'],
1435           [:publicrec, 'Public recreational green space (e.g. parks)'],
1436           [:nonrec, 'Other kinds of green space']
1437         option_separator
1438         exclusive_option [:none, 'None of the above']
1439       end
1440     )
1441
1442     # how much time you spend there?
1443
1444   end,
1445   skip_unless { Q::OtherPlaceType.answer && Q::OtherPlaceType.answer != :none },
1446   P::LeisureActivities = P::Wellbeing.declare_new do # ESS E1 - E3
1447     title 'Leisure activities'
1448
1449     text 'In the past 12 months how often have you... '
1450     questions(
1451       # partly adapted from BHPS 2006, RV10 & General Household Survey 2006
1452       Q::Newspaper = Q::Frequency.declare_new do
1453         text '... read a newspaper?'
1454         text 'Please *include* newspaper articles you read online.', :style => :smaller
1455       end,
1456       Q::DoSport = Q::Frequency.declare_new do
1457         text '... played sport, or done other vigorous physical exercise?'
1458         text 'This could include going to the gym, taking exercise classes, running, cycling, skating or swimming.', :style => :smaller
1459       end,
1460       Q::SeeLiveArts = Q::Frequency.declare_new { text '... gone to a concert, theatre or other live performance?' },
1461       Q::SeeDeadArts = Q::Frequency.declare_new { text '... visited historical monuments, museums, art galleries or archaeological sites?' },
1462       Q::Meditation = Q::Frequency.declare_new { text '... practiced meditation?' }
1463     )
1464
1465     question_separator
1466     text 'Please take a moment to think of any groups, clubs or organisations you take part in. These could be youth groups, sports clubs or pub teams, religious groups, evening classes, choirs, book groups, or any other groups, clubs or organisations.'
1467     questions(
1468       Q::ClubsGroupsEtc = Q::EssFrequency.declare_new do
1469         text 'In the past 12 months, how often did you take part in all groups, clubs or organisations like this combined?'
1470       end
1471     )
1472
1473     question_separator
1474     questions(
1475       Q::EssVoluntaryOrgs = Q::EssFrequency.declare_new do # ESS E1
1476         text 'In the past 12 months, how often did you get involved in work for voluntary or charitable organisations?'
1477       end,
1478       Q::EssHelp = Q::EssFrequency.declare_new do # ESS E2
1479         # What does this question MEAN?
1480         text 'Not counting anything you do for your family, in your work, or within voluntary organisations, how often, in the past 12 months, did you actively provide help for other people?'
1481       end,
1482       Q::EssLocalActivities = Q::EssFrequency.declare_new do # ESS E3
1483         text 'And in the past 12 months, how often did you help with or attend activities organised in your local area?'
1484       end
1485     )
1486
1487     question_separator
1488     questions(
1489       Q::CarOwnership = Q::Radio.declare_new do
1490         text 'Is there a car or van normally available for private use by you or any members of your household? # BHPS 2006, H61'
1491         options [2, 'Yes--more than one'],
1492           [1, 'Yes--one'],
1493           [0, 'No--none']
1494       end
1495     )

```

```

1497   progress_weight 2
1498 end,
1499 P::Demographics = P::Wellbeing.declare_new do
1500   title 'Demographics'
1501
1502   questions(Q::Male, Q::Age) unless toluna_respondent_cond.call
1503   questions(
1504     Q::MaritalStatus = Q::Radio.declare_new do
1505       text 'What is your marital status?'
1506       text 'Please choose the *first* option that applies. For all response options, please treat *Civil Partnership* as equivalent to marriage.', :style => :smaller
1507       options [:single, 'Single (never married--but may be in a relationship)'],
1508         [:married, 'Married and living with your husband or wife'],
1509         [:separated, 'Married and separated from your husband or wife'],
1510         [:divorced, 'Divorced'],
1511         [:widowed, 'Widowed']
1512   end,
1513
1514   Q::InCoupleOrRel = Q::Radio.declare_new do
1515     show_if :condition => -> { [:single, :separated, :divorced, :widowed].include?(Q::MaritalStatus.answer) },
1516       :js_condition => "return $A(['single', 'separated', 'divorced', 'widowed']).include(<=% Q::MaritalStatus.js_instance %>.answer());",
1517       :human_condition => 'Please complete the following question only if you answered "Single", "Married and separated", "Divorced", or "Widowed" above.'
1518
1519     text 'And are you currently...'
1520     options [2, 'living with someone as a couple, or'],
1521       [1, 'in a relationship with someone, but not living together, or'],
1522       [0, 'neither of the above?']
1523   end,
1524
1525   Q::AnyChildren = Q::Radio.declare_new do
1526     text 'Do you have any children?'
1527     options [2, 'Yes--more than one'],
1528       [1, 'Yes--one'],
1529       [0, 'No--none']
1530   end,
1531
1532   Q::AnyChildrenAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::AnyChildren },
1533
1534   Q::ChildOfAge = Q::Radio.declare_new do
1535     show_if :condition => -> { Q::AnyChildren.answer == 1 },
1536       :js_condition => "return <=% Q::AnyChildren.js_instance %>.answer() == 1;",
1537       :human_condition => "Please complete the following question only if you answered 'Yes--one' above."
1538
1539     text 'What is your child's age?'
1540     option [0, 'Under 2 years']
1541     options discrete_numeric_bands [2, 5, 11, 16, 21, :unbounded],
1542       :top_unbounded => ' or over'
1543   end,
1544
1545   Q::ChildrenOfAges = Q::Checkbox.declare_new do
1546     show_if :condition => -> { Q::AnyChildren.answer == 2 },
1547       :js_condition => "return <=% Q::AnyChildren.js_instance %>.answer() == 2;",
1548       :human_condition => "Please complete the following question only if you answered 'Yes--more than one' above."
1549
1550     text 'What are your children's ages?'
1551     text 'Please tick *all* that apply.', :style => :smaller
1552     option [0, 'Under 2 years']
1553     options discrete_numeric_bands [2, 5, 11, 16, 21, :unbounded],
1554       :top_unbounded => ' or over'
1555   end,
1556
1557   Q::Qualifications = Q::Radio.declare_new do
1558     text 'What qualifications do you have?'
1559     text 'These may be educational, professional, vocational or other work-related qualifications.', :style => :smaller
1560     options [2, 'Qualifications at degree level or above'],
1561       [1, 'Qualifications below degree level'],
1562       [0, 'No qualifications']
1563   end
1564 )
1565 end,
1566 P::WorkStatus = P::Wellbeing.declare_new do
1567   title 'Work status'
1568
1569   questions(
1570     Q::WorkStatus,
1571     Q::WorkStatusAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::WorkStatus },
1572     Q::WorkStatusOther = Q::Text.declare_new do
1573       show_if :condition => -> { Q::WorkStatus.answer == :other },
1574         :js_condition => "return <=% Q::WorkStatus.js_instance %>.answer() == 'other';",
1575         :human_condition => "Please complete this question only if you answered 'Something else' above."
1576
1577       text 'Please describe your current situation'
1578       text_box :size => '50x1'
1579     end
1580   )
1581
1582   progress_weight 0.25

```

```

1583     end,
1584     skip_if { toluna_respondent_cond.call || [0, 10].include?(Q::Age.answer) },
1585   P::Job = P::Wellbeing.declare_new do
1586     title 'Work hours and activities'
1587
1588     question(
1589       Q::WorkHoursFortyEight = Q::Radio.declare_new do # from NatCen/DTI Workplace Employment Relations Survey 2004
1590         text 'Excluding holidays, in the last 12 months how often have you worked more than 48 hours in a week?'
1591         options [5, 'Every week'],
1592                 [4, 'Several times a month'],
1593                 [3, 'Once a month'],
1594                 [2, 'Less than once a month'],
1595                 [1, 'Never']
1596     end
1597   )
1598
1599   text 'Please tick all the statements that apply.'
1600   questions(
1601     Q::JobActivity = Q::Checkbox.declare_new do
1602       text 'In my work, I spend *at least half my time*...'
1603       options [:desk, '.... at a desk',
1604                 [:computer, '... using a computer'],
1605                 [:outside, '... in the open air'],
1606                 [:active, '... being physically active'],
1607                 [:communicating, '... communicating face-to-face with others'],
1608                 [:travelling, '... travelling']]
1609     option_separator
1610     exclusive_option [:none, 'None of the above']
1611   end
1612 )
1613
1614   progress_weight 0.5
1615 end,
1616 skip_unless { [:emp, :self_emp].include?(Q::WorkStatus.answer) || Q::EssRoutingWork.answer == 1 },
1617 P::Income = P::Wellbeing.declare_new do
1618   title 'Income'
1619
1620   text "*The wellbeing effect of income, relative to other factors, is an important part of our research*, so we
1621   would be very grateful for your answers here.
1622
1623   *Please be assured that your information is confidential and secure* (click '<%= help_page[:text] %>', above
1624   right, to find out more).
1625
1626   Remember that in this survey a *household* means:
1627
1628   * one person living alone, or
1629   * a group of people living at the same address who share common housekeeping or a living room.", :style => :info
1630
1631   questions(
1632     Q::HouseholdIncome = Q::Income.declare_new do
1633       text %Q{What is your *household's* total gross annual income? This is:
1634
1635       * for all household members,
1636       * from all sources (earnings, benefits, investments, etc.), and
1637       * before taxes and National Insurance.}
1638
1639       completion :prompted, :message => "*You don't have to give an answer here, but we would really appreciate it
1640       if you did.* The wellbeing effect of income relative to other factors is one of the key issues in our
1641       research."
1642     end,
1643
1644     Q::IndividualIncome = Q::Income.declare_new do
1645       text %Q{And what is your own *individual* total gross annual income? Again, this is:
1646
1647       * from all sources (earnings, benefits, investments, etc.), and
1648       * before taxes and National Insurance.}
1649
1650       completion :prompted, :message => "*You don't have to give an answer here, but we would really appreciate it
1651       if you did.* The wellbeing effect of income relative to other factors is one of the key issues in our
1652       research."
1653     end
1654   )
1655
1656   # number of incomes?
1657   progress_weight 0.5
1658 end,
1659
1660 P::ReligionPolitics = P::Wellbeing.declare_new do
1661   title 'Religion and politics'
1662
1663   # all questions verbatim from ESS: C17, 21, 22, 23
1664
1665   questions(
1666     Q::AnyReligion = Q::YesNo.declare_new do
1667       text 'Do you consider yourself as belonging to any particular religion or denomination?'
1668     end,
1669
1670     Q::AnyReligionAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::AnyReligion },
1671
1672     Q::WhichReligion = Q::Radio.declare_new do
1673       show_if :condition => -> { Q::AnyReligion.answer == 1 },

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1668         :js_condition => "return <%= Q::AnyReligion.js_instance %>.answer() == 1;",
1669         :human_condition => "Please complete this question only if you answered 'Yes' above."
1670     text 'Which one?'
1671     options [[:catholic, 'Roman Catholic'],
1672               [:protestant, 'Protestant'],
1673               [:orthodox, 'Eastern Orthodox'],
1674               [:other_chr, 'Other Christian denomination'],
1675               [:jewish, 'Jewish'],
1676               [:islamic, 'Islamic'],
1677               [:eastern, 'Eastern religions'],
1678               [:other_non_chr, 'Other non-Christian religions']]
1679   end,
1680
1681 Q::HowReligious = Q::ScaleHorizontal.declare_new do
1682   text 'Regardless of whether you belong to a particular religion, how religious would you say you are?'
1683   scale :range => 0..10,
1684         :start => "Not at all \n religious",
1685         :end => "Very \n religious"
1686 end,
1687
1688 Q::ReligiousServices = Q::ReligiousFrequency.declare_new do
1689   text 'Apart from special occasions such as weddings and funerals, about how often do you attend religious
1690         services nowadays?'
1691 end
1692
1693 question_separator
1694 questions(
1695   Q::PoliticalInterest = Q::RadioHorizontal.declare_new do
1696     text 'How interested would you say you are in politics?'
1697     options [4, 'Not at all interested'],
1698             [3, 'Hardly interested'],
1699             [2, 'Quite interested'],
1700             [1, 'Very interested']
1701   end,
1702
1703 Q::PoliticsLeftRight = Q::ScaleHorizontal.declare_new do
1704   text 'In politics people sometimes talk of "left" and "right". Where would you place yourself on this scale?'
1705   scale :range => 0..10,
1706         :start => 'Left',
1707         :end => 'Right',
1708         :others => [[:dk, '', "Don't know"]]
1709 end
1710 )
1711 end,
1712
1713 P::FamilyBackground = P::Wellbeing.declare_new do
1714   title 'Your family background'
1715   text 'These questions are about you and your family when you were growing up.'
1716
1717 # Questions mainly adapted from National Survey of Sexual Attitudes and Lifestyles 2000
1718
1719 assumed_still_home = Q::Age.answer && Q::Age.answer.to_i < 16
1720
1721 questions(
1722
1723   Q::Brothers = Q::Radio.declare_new do
1724     text 'Do you have, or did you have, any *brothers*?'
1725     text 'Please include adopted and half brothers.', :style => :smaller
1726     options [2, 'Yes--more than one'],
1727             [1, 'Yes--one'],
1728             [0, 'No--none']
1729   end,
1730
1731   Q::BrothersAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::Brothers },
1732
1733   Q::Sisters = Q::Radio.declare_new do
1734     text 'Do you have, or did you have, any *sisters*?'
1735     text 'Please include adopted and half sisters.', :style => :smaller
1736     options [2, 'Yes--more than one'],
1737             [1, 'Yes--one'],
1738             [0, 'No--none']
1739   end,
1740
1741   Q::SistersAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::Sisters },
1742
1743   Q::BirthPosTwo = Q::Radio.declare_new do
1744     show_if :condition => -> { Q::Brothers.answer.to_i + Q::Sisters.answer.to_i == 1 },
1745     :js_condition => "return parseInt(<%= Q::Brothers.js_instance %>.answer() || 0) + parseInt(<%= Q::
1746           Sisters.js_instance %>.answer() || 0) == 1;",
1747     :human_condition => "Please complete this question only if you have (or had) one brother or sister."
1748
1749     text 'Which of you is, or was, older?'
1750     options [[:oldest, 'Me'],
1751               [:youngest, 'My brother or sister']]
1752   end,
1753
1754   Q::BirthPosMany = Q::Radio.declare_new do
1755     show_if :condition => -> { Q::Brothers.answer.to_i + Q::Sisters.answer.to_i > 1 },
1756     :js_condition => "return parseInt(<%= Q::Brothers.js_instance %>.answer() || 0) + parseInt(<%= Q::
1757           Sisters.js_instance %>.answer() || 0) > 1;",

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```

1756         :human_condition => "Please complete this question only if you have (or had) two or more brothers and
1757         sisters."
1758
1759     text 'Are you, or were you, the oldest, the youngest, or somewhere in between?'
1760     options [:oldest, 'Oldest'],
1761             [:youngest, 'Youngest'],
1762             [:between, 'In between']
1763   end
1764 )
1765
1766 question_separator
1767 questions(
1768   Q::NaturalParents = Q::Radio.declare_new do
1769     text assumed_still_home ?
1770       'Have you lived more or less continuously with *both* of your natural (birth) parents in the same home?' :
1771       'Did you live more or less continuously with *both* of your natural (birth) parents in the same home until
1772       you were 16?'
1773     text "If you #{assumed_still_home ? 'have' : ''} lived with your natural parents except when away at a
1774       boarding school or for other temporary periods, please answer 'Yes'.", :style => :smaller
1775
1776     options [1, 'Yes'],
1777           [0, 'No'],
1778           [:na, 'Prefer not to answer']
1779
1780   completion :optional
1781 end,
1782
1783 Q::WhyNotNaturalparents = Q::Radio.declare_new do
1784   show_if :condition => lambda { Q::NaturalParents.answer == 0 },
1785     :human_condition => "Please complete this question only if you answered 'No' above.",
1786     :js_condition => "return <=> Q::NaturalParents.js_instance %>.answer() == 0;"
1787
1788   text "Why #{assumed_still_home ? 'is' : 'was'} this?"
1789   options [:split, 'There was a divorce or separation'],
1790             [:death, 'There was a death'],
1791             [:adopted, 'I was adopted'],
1792             [:never_together, 'My parents never lived together'],
1793             [:other, 'Another reason'],
1794             [:na, 'Prefer not to answer']
1795
1796   completion :optional
1797 end
1798 )
1799
1800 P::Shocks = P::Wellbeing.declare_new do
1801   title 'Negative events'
1802   question(
1803     Q::Shocks = Q::Checkbox.declare_new do
1804       text 'Have you suffered any of the following *in the last 3 years*?'
1805       text 'Please tick *all* that apply.', :style => :smaller
1806       options [:unemployment, 'Compulsory redundancy'],
1807             [:bankruptcy, 'Bankruptcy'],
1808             [:repossession, 'Repossession of your home'],
1809             [:bereavement, 'Death of a close friend or loved one'],
1810             [:divorce, 'Separation or divorce from your spouse'],
1811             [:othercrime, 'Theft or fraud'],
1812             [:violentcrime, 'Violent or sexual crime']
1813
1814   option_separator
1815   exclusive_option [:none, 'None of the above']
1816 end
1817 )
1818 progress_weight 0.5
1819
1820 P::Cycle = P::Wellbeing.declare_new do
1821   title 'Pregnancy and menstrual cycle'
1822   text "*We recognise that these are very personal questions, so please feel free not to answer them.* We ask them
1823     because we are interested in whether they have a measurable effect on day-to-day wellbeing.", :style => :
1824     info
1825
1826   questions(
1827     Q::Pregnant = Q::Radio.declare_new do
1828       text "As far as you're aware, are you pregnant?"
1829       options [1, 'Yes'],
1830             [0, 'No'],
1831             [:refused, 'Prefer not to answer']
1832
1833     completion :optional
1834   end,
1835
1836   Q::Period = Q::Radio.declare_new do
1837     show_if :condition => -> { Q::Pregnant.answer != 1 },
1838       :js_condition => "return <=> Q::Pregnant.js_instance %>.answer() != '1';",
1839       :human_condition => "Please complete this question only if you answered 'No' above."
1840
1841   text "Where are you currently in your menstrual cycle?"
1842   options [:on, "I've got my period now"],
1843             [:recent, "My last period finished within the last 3 days"],
1844             [:expected, "I expect my next period to start within the next 3 days"],
```

```

1842         [::mid_cycle, "I'm at some other point in my cycle"],
1843         [::na, 'Not applicable'],
1844         [::dk, 'Not sure'],
1845         [::refused, 'Prefer not to answer']
1846     completion :optional
1847   end
1848 )
1849 progress_weight 0.5
1850 end,
1851 skip_unless { Q::Male.answer == 0 && Q::Age.answer && Q::Age.answer >= 16 && Q::Age.answer <= 45},
1852 P::Ethnicity = P::Wellbeing.declare_new do
1853   title 'Ethnicity'
1854   text "*Almost finished.* To help ensure we survey a representative group of people, we'd be grateful if you'd
1855     answer this final, optional question.", :style => :info
1856 questions(
1857   Q::Ethnicity = Q::Radio.declare_new do # GB Census 2001 question
1858     text 'To which of these ethnic groups do you consider you belong?'
1859
1860     text '_White_'
1861     indent
1862     options [1, 'White British'],
1863       [5, 'Any other white background']
1864     unindent
1865
1866     text '_Mixed_'
1867     indent
1868     options [6, 'White and Black Caribbean'],
1869       [7, 'White and Black African'],
1870       [8, 'White and Asian'],
1871       [9, 'Any other mixed background']
1872     unindent
1873
1874     text '_Asian or Asian British_'
1875     indent
1876     options [10, 'Indian'],
1877       [11, 'Pakistani'],
1878       [12, 'Bangladeshi'],
1879       [13, 'Any other Asian background']
1880     unindent
1881
1882     text '_Black or Black British_'
1883     indent
1884     options [14, 'Caribbean'],
1885       [15, 'African'],
1886       [16, 'Any other Black background']
1887     unindent
1888
1889     option_separator
1890     option [17, 'Chinese']
1891
1892     option_separator
1893     option [0, 'Prefer not to answer']
1894
1895     completion :optional
1896   end,
1897
1898   Q::EthnicityOther = Q::Text.declare_new do
1899     show_if :condition => -> { [5, 9, 13, 16, 18].include?(Q::Ethnicity.answer) },
1900       :js_condition => "return $A([5, 9, 13, 16, 18]).include(<%= Q::Ethnicity.js_instance %>.answer());",
1901       :human_condition => "Please complete this question only if you chose one of the 'Any other...'"
1902       options above."
1903
1904     text 'What is the other background or ethnic group to which you consider you belong?'
1905     text_box :size => '40x1'
1906
1907     completion :optional
1908   end
1909 )
1910
1911 forward_prompt 'Finish and submit answers &#187;'
1912 progress_weight 0.25
1913 end,
1914 P::TolunaCompletion = P::Redirect.declare_new do
1915   completes_survey true
1916   destination_url (RAILS_ENV == 'production' ? 'http://as.automatesurvey.com/SOP/P29994369730307252C' : 'http://www
1917     .google.com/search?q=completed')
1918   skip_unless { toluna_respondent_cond.call },
1919   P::Thanks.declare do
1920     title 'Thank you'
1921     text contents_of_file 'thanks_text.txt'
1922     suppress_backward true
1923     completes_survey true
1924     progress_weight 0
1925     help_page nil
1926   end
1927 )
1928 end

```

A.5.2 UK

```
1 # encoding: utf-8
2 $VERBOSE = nil
3
4 # UK wellbeing and EQ survey
5 # George MacKerron 2010
6
7 # Reusable question types (fold)
8 Q::Satisfaction = Q::ScaleHorizontal.declare_new do
9   insert_future_layout
10  scale :range => 0..10,
11    :start => "Extremely\\ndissatisfied",
12    :end => "Extremely\\nsatisfied"
13 end
14 Q::Frequency = Q::Radio.declare_new do
15   insert_future_layout
16
17 # from ESS q C2 -- required for ESS wellbeing module, social meeting q
18 options [7, 'Every day'],
19   [6, 'Several times a week'],
20   [5, 'Once a week'],
21   [4, 'Several times a month'],
22   [3, 'Once a month'],
23   [2, 'Less than once a month'],
24   [1, 'Never']
25 end
26 Q::EssFrequency = Q::Radio.declare_new do
27   insert_future_layout
28   options [1, 'At least once a week'],
29     [2, 'At least once a month'],
30     [3, 'At least once every three months'],
31     [4, 'At least once every six months'],
32     [5, 'Less often'],
33     [6, 'Never']
34 end
35 Q::Oftenness = Q::Radio.declare_new do
36   insert_future_layout
37   options [0, 'None'],
38     [1, 'Once or twice'],
39     [3, '3 - 5 times'],
40     [5, '6 - 11 times'],
41     [7, '12 times or more']
42 end
43 Q::YesNo = Q::Radio.declare_new do
44   insert_future_layout
45   options [1, 'Yes'], [0, 'No']
46 end
47 Q::YesNoRegularity = Q::Radio.declare_new do
48   insert_future_layout
49   options [2, 'Yes, regularly'],
50     [1, 'Yes, occasionally'],
51     [0, 'No']
52 end
53 class Q::BorderlessPostcode < Q::Postcode
54   include Q::Borderlessness
55 end
56 Q::ScaleOfProblem = Q::RadioHorizontal.declare_new do
57   insert_future_layout
58   options [1, "A serious problem"],
59     [2, "A problem,\\nbut not serious"],
60     [3, "Not a problem"]
61 end
62 Q::ReligiousFrequency = Q::Radio.declare_new do
63   insert_future_layout
64   options [1, 'Every day'],
65     [2, 'More than once a week'],
66     [3, 'Once a week'],
67     [4, 'At least once a month'],
68     [5, 'Only on special holy days'],
69     [6, 'Less often'],
70     [7, 'Never']
71 end
72 Q::SleepHours = Q::Dropdown.declare_new do
73   insert_future_layout
74   options [3, '3 hours or fewer'],
75     [3.5, '3.5 hours'],
76     [4, '4 hours'],
77     [4.5, '4.5 hours'],
78     [5, '5 hours'],
79     [5.5, '5.5 hours'],
80     [6, '6 hours'],
81     [6.5, '6.5 hours'],
82     [7, '7 hours'],
83     [7.5, '7.5 hours'],
84     [8, '8 hours'],
85     [8.5, '8.5 hours'],
86     [9, '9 hours'],
87     [9.5, '9.5 hours'],
```

```

88     [10, '10 hours or more']
89 end
90 Q::Income = Q::Dropdown.declare_new do
91   insert_future_layout
92   text 'If you are not certain of an amount, please give your best estimate.', :style => :smaller
93   options monetary_bands [:unbounded,
94     4000,
95     6000,
96     8000,
97     10000,
98     12000,
99     15000,
100    18000,
101    20000,
102    23000,
103    26000,
104    29000,
105    32000,
106    38000,
107    44000,
108    50000,
109    56000,
110    68000,
111    80000,
112    100000,
113    150000,
114    200000,
115    400000,
116    800000,
117    :unbounded]
118 end
119 Q::TimePerDay = Q::Radio.declare_new do
120   insert_future_layout
121   options [15, 'Less than 30 minutes'],
122     [45, '30 minutes but less than 60 minutes'],
123     [75, '60 minutes but less than 90 minutes'],
124     [105, '90 minutes but less than 2 hours'],
125     [180, '2 hours but less than 4 hours'],
126     [300, '4 hours but less than 6 hours'],
127     [480, '6 hours or more']
128 end
129 Q::AmountOfThisTime = Q::Radio.declare_new do
130   insert_future_layout
131   options [4, 'All of this time'],
132     [3, 'Most of this time'],
133     [2, 'Some of this time'],
134     [1, 'A little of this time'],
135     [0, 'None of this time']
136 end
137 # (end)
138
139 # Custom page stuff (fold)
140 Q::MetaQuestion = Q::Text.declare_new do
141   text '*Survey pilot phase.* Please enter any comments or suggestions here.'
142   text_box :size => '70x5', :full_width => true
143   completion :optional
144   no_next_prompt
145 end
146 Q::PageComment = Q::Text.declare_new do
147   show_if :js_condition => "return window.Websperiment$add_comment;",
148   :human_condition => "This question is completely optional."
149   text 'If there's anything you'd like to add, please use this space.'
150   text_box :size => '70x3', :full_width => true
151   completion :optional
152   no_next_prompt
153 end
154 class P::Wellbeing < P::Base
155   def suppress_comment; false; end
156   declare do
157     insert_future_layout
158
159     # Timing of first layout = first GET request
160     question(eval("Datum::#{name}.demodulize}PageFirstLook = Datum::FirstLayoutTime.declare_new"))
161
162     # Add a comment link
163     unless (suppress_comment)
164       question(eval("Q::#{name}.demodulize}PageComment = Q::PageComment.declare_new"))
165       markup %q{
166         <div class="hide_bottom_border"></div>
167         <div id="add_comment" style="display: none;"><a href="#comment" onclick="window.Websperiment$add_comment = true
168           ; $(this).up('div').hide_animated(); return false;">add a comment</a></div>
169       }
170       local_js %q{
171         document.observe('dom:loaded', function() {
172           var p = $('#add_comment');
173           if (p) {
174             var q = Page.questions.last();
175             if (q.answer()) {
176               Websperiment$add_comment = true;
177               q.show();
178             } else p.show();
179           }
180         }
181       }

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```

178         }
179     });
180   }
181 end
182 css %Q{
183   #add_comment { font-size: 0.85em; text-align: right; }
184   #add_comment a {
185     color: #666;
186     padding-left: 11px;
187     background: #fff url(/images/plus.png) 0% 50% no-repeat;
188   }
189 }
190
191 help_page :text => 'Help & information', :name => 'P::MoreInfo'
192
193 # Piloting meta-question
194 css '.pilot_evaluation { color: #fff; padding: 0 1em; background: #666; margin-top: 2em; }'
195 if Respondent.current.andand.referral_data.andand.match(/\bpilot\b/)
196   markup '<div class="pilot_evaluation">'
197   question(eval("Q::#{name.demodulize}PageEvaluation = Q::MetaQuestion.declare_new"))
198   markup '</div>'
199 end
200
201 end
202 end
203 class P::Welcome < P::Wellbeing
204   def suppress_comment; true; end
205 end
206 class P::MoreInfo < P::Wellbeing
207   def suppress_comment; true; end
208 end
209 class P::Thanks < P::Wellbeing
210   def suppress_comment; true; end
211 end
212 # (end)
213
214 # Screening and quotas stuff (fold)
215 screening_completion_message = '*Did you miss this question?* Please provide an answer here.'
216 toluna_respondent_cond = -> { Respondent.current.andand.referral_data.andand.match(/\btoluna\b/) }
217
218 Quotas::Wellbeing = Quotas::Base.declare_new do
219   quota :on => :age,
220     :categories => [:age_16_to_34, :age_35_to_54, :age_55_plus, :under_16],
221     :classify => -> {
222       a = Q::Age.answer
223       return nil unless a
224       return :under_16 if [0, 10].include? a
225       return :age_16_to_34 if [16, 20, 25, 30].include? a
226       return :age_35_to_54 if [35, 40, 45, 50].include? a
227       return :age_55_plus
228     }
229   quota :on => :gender,
230     :categories => [:male, :female],
231     :classify => -> {
232       a = Q::Male.answer
233       return nil unless a
234       return :male if a == 1
235       return :female if a == 0
236     }
237   quota :on => :employment,
238     :categories => [:employee, :not_employee],
239     :classify => -> {
240       a = Q::WorkStatus.answer
241       return nil unless a
242       return :employee if [:emp, :govt_train].include?(a)
243       return :not_employee
244     }
245   quota :on => :region,
246     :categories => [:north, :midlands_east, :london, :south, :scotwalni, :unknown],
247     :classify => -> {
248       a = Q::HomePostcode.answer
249       return nil unless a
250       pc = Postcode.lookup(a)
251       return nil unless pc
252       return :north      if %w{A B D}.include?(pc.go_region)
253       return :midlands_east if %w{E F G}.include?(pc.go_region)
254       return :london     if %w{H}.include?(pc.go_region)
255       return :south      if %w{J K}.include?(pc.go_region)
256       return :scotwalni  if %w{W X Y}.include?(pc.go_region)
257       return :unknown
258     }
259   numbers contents_of_file 'quotas.yml'
260 end
261 # (end)
262
263 # SF-36 + PANAS generic question types (fold)
264 Q::RandLimitation = Q::RadioHorizontal.declare_new do
265   insert_future_layout
266   options [1, 'Yes, limited a lot'],
267           [2, 'Yes, limited a little'],
268           [3, 'No, not limited at all']

```

```

269 end
270 Q::RandTimeProp = Q::RadioHorizontal.declare_new do
271   insert_future_layout
272   options [1, 'All of the time'],
273     [2, 'Most of the time'],
274     [3, 'A good bit of the time'],
275     [4, 'Some of the time'],
276     [5, 'A little of the time'],
277     [6, 'None of the time']
278 end
279 Q::RandTrueness = Q::RadioHorizontal.declare_new do
280   insert_future_layout
281   options [1, 'Definitely true'],
282     [2, 'Mostly true'],
283     [3, "Don't know"],
284     [4, 'Mostly false'],
285     [5, 'Definitely false']
286 end
287 Q::Panas = Q::RadioHorizontal.declare_new do
288   insert_future_layout
289   options [1, 'Very slightly or not at all'],
290     [2, 'A little'],
291     [3, 'Moderately'],
292     [4, 'Quite a bit'],
293     [5, 'Extremely']
294 end
295 # (end)
296
297 exercises = [ [:walk, 'Walking to get somewhere', 'walk to get somewhere'],
298   [:leisurewalk, 'Rambling, hiking, walking for leisure', 'ramble, hike, or walk for leisure'],
299   [:run, 'Jogging, running', 'jog or run'],
300   [:cycle, 'Cycling', 'cycle'],
301   [:swim, 'Swimming', 'swim'],
302   [:exercise, 'Gym, weight training, or keep fit classes', 'do gym, weight training, or keep fit classes'],
303   [:sports, 'Playing sports', 'play sport'],
304   [:dance, 'Dancing', 'go dancing'],
305   [:garden, 'Gardening or working on an allotment', 'do gardening or work on an allotment'],
306   [:home, 'Heavy manual work around the home', 'do heavy manual work around the home'],
307   [:job, 'Heavy manual work as part of your job', 'do heavy manual work as part of your job'] ]
308
309 S::Wellbeing = S::Base.declare_new do
310   title '*Wellbeing survey* -- LSE'
311   quotas Quotas::Wellbeing
312   pages(
313     P::Welcome.declare do
314       text contents_of_file 'welcome_text.txt'
315       text %Q{*Want to know more?* <a href="<%= eval(help_page[:name]).url %>" target="_new">See more details now</a>, or click '<%= help_page[:text] %>' at the top right of any page.}, :style => :info
316       forward_prompt 'Start survey &#187;'
317       progress_bar :hidden
318     end,
319     P::MoreInfo.declare do # mention MRS CoC, or Data Protection?
320       title help_page[:text]
321       text (contents_of_file (toluna_respondent_cond.call ? 'contact_text_toluna.txt' : 'contact_text.txt')), :style =>
322         :float_info
323       text contents_of_file 'info_text.txt'
324       text '*Please <a href="#close_window" onclick="window.close();">close this window or tab</a>* to return to the survey.', :style => :info
325       suppress_forward on
326       suppress_backward on
327       progress_bar :hidden
328       progress_weight 0
329     end,
330     skip_always,
331   )
332   # screening section (fold)
333   P::Basics = P::Wellbeing.declare_new do
334     questions(
335       Q::Male = Q::Radio.declare_new do
336         text 'Are you male or female?'
337         options [1, 'Male'],
338           [0, 'Female']
339         completion :mandatory, :message => screening_completion_message
340       end,
341       Q::Age = Q::Dropdown.declare_new do
342         text 'What is your age?'
343         option [0, 'Under 10 years']
344         options_discrete_numeric_bands [10, 16, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, :unbounded],
345           :top_unbounded => 'or over'
346         completion :mandatory, :message => screening_completion_message
347       end,
348       Q::HomePostcode = Q::Postcode.declare_new do
349         text "What is your full home postcode?"
350         validate -> { %{*This postcode isn't recognised.* You can "check it with Royal Mail":http://postcode.royalmail.com/. If your correct postcode isn't recognised, then unfortunately you won't be able to take part in this survey.} unless self.answer && Postcode.is_valid?(self.answer) }
351         completion :optional # not actually optional, but blanks will be caught by validation
352       end,
353       Q::WorkStatus = Q::Radio.declare_new do
354         # BHPS 2006, D29; and Families & Children Study 2006 - NatCen/DWP
355         text 'Which of these best describes your current situation?'

```

```

355     options [:self_emp, 'Self-employed'],
356         [:emp, 'In paid employment (full- or part-time)'],
357         [:fte, 'In full-time education'],
358         [:retired, 'Retired from paid work altogether'],
359         [:unemp, 'Unemployed and seeking work'],
360         [:parental, 'On maternity leave'],
361         [:govt_train, 'On a government training scheme'],
362         [:home_family, 'Looking after family or home'],
363         [:caring, 'Caring for a sick, elderly or disabled person'],
364         [:sick, 'Long term sick or disabled'],
365         [:other, 'Something else']
366     completion :mandatory, :message => screening_completion_message
367 end,
368 Q::WorkStatusAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::WorkStatus },
369 Q::WorkStatusOther = Q::Text.declare_new do
370   show_if :condition => -> { Q::WorkStatus.answer == :other },
371   :js_condition => "return <%= Q::WorkStatus.js_instance %>.answer() == 'other';",
372   :human_condition => "Please complete this question only if you answered 'Something else' above."
373
374   text 'Please describe your current situation'
375   text_box :size => '50x1'
376 end
377 )
378 end,
379 P::ScreenOut = P::Redirect.declare_new do
380   respondent_not_eligible true
381   destination_url (RAILS_ENV == 'production' ? 'http://ups.surveyrouter.com/SurveyTrafficUI/STMUI/soterminated.aspx'
382   ' : 'http://www.google.com/search?q=screen_out')
383   skip_unless { toluna_respondent_cond.call && quotas.current_respondent_out_of_scope? },
384 P::QuotaFull = P::Redirect.declare_new do
385   respondent_not_eligible true
386   destination_url (RAILS_ENV == 'production' ? 'http://ups.surveyrouter.com/SurveyTrafficUI/STMUI/squotafull.aspx'
387   ' : 'http://www.google.com/search?q=quota_full')
388   skip_unless { toluna_respondent_cond.call && quotas.current_respondent_quota_full? },
389 #(end)
390
391 # wellbeing section: LS + RAND SF-36 + PANAS (fold)
392 P::LifeSat = P::Wellbeing.declare_new do # B24
393   #text 'The next several pages are about your life satisfaction and general wellbeing.', :style => :info
394   questions(
395     Q::LifeSat = Q::Satisfaction.declare_new do # B24
396       text "All things considered, how satisfied are you with your life as a whole nowadays?"
397       completion :prompted,
398       :message => "We'd be very grateful if you'd provide a response to this question: it represents a
399       key part of our research topic."
400     end
401   )
402   progress_weight 0.5
403 end,
404 P::RandOne = P::Wellbeing.declare_new do
405   #title 'General health'
406   questions(
407     Q::Rand01GeneralHealth = Q::Radio.declare_new do
408       text 'In general, would you say your health is...'
409       options [1, 'Excellent'],
410             [2, 'Very good'],
411             [3, 'Good'],
412             [4, 'Fair'],
413             [5, 'Poor']
414   end,
415   Q::Rand02HealthYearAgo = Q::Radio.declare_new do
416     text '*Compared to one year ago*, how would you rate your health in general *now*?'
417     options [1, 'Much better now than one year ago'],
418             [2, 'Somewhat better now than one year ago'],
419             [3, 'About the same'],
420             [4, 'Somewhat worse now than one year ago'],
421             [5, 'Much worse now than one year ago']
422   end
423 end,
424 P::RandTwo = P::Wellbeing.declare_new do
425   text 'The following items are about activities you might do during a typical day.'
426   text 'Does *your health now limit you* in these activities? If so, how much?'
427   questions(
428     Q::Rand03LimitVigor = Q::RandLimitation.declare_new do
429       text '*Vigorous activities*, such as running, lifting heavy objects, participating in strenuous sports'
430     end,
431     Q::Rand04LimitModerate = Q::RandLimitation.declare_new do
432       text '*Moderate activities*, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf'
433     end,
434     Q::Rand05LimitGroceries = Q::RandLimitation.declare_new do
435       text 'Lifting or carrying groceries'
436     end,
437     Q::Rand06LimitSeveralStairs = Q::RandLimitation.declare_new do
438       text 'Climbing *several* flights of stairs'
439     end,
440     Q::Rand07LimitOneStairs = Q::RandLimitation.declare_new do
441       text 'Climbing *one* flight of stairs'
442     end,

```

```

443     Q::Rand08LimitBend = Q::RandLimitation.declare_new do
444         text 'Bending, kneeling, or stooping'
445     end,
446     Q::Rand09LimitMoreMile = Q::RandLimitation.declare_new do
447         text 'Walking *more than a mile*'
448     end,
449     Q::Rand10LimitBlocks = Q::RandLimitation.declare_new do
450         text 'Walking *several blocks*'
451     end,
452     Q::Rand11LimitBlock = Q::RandLimitation.declare_new do
453         text 'Walking *one block*'
454     end,
455     Q::Rand12LimitBatheDress = Q::RandLimitation.declare_new do
456         text 'Bathing or dressing yourself'
457     end
458 )
459     progress_weight 1.5
460 end,
461 P::RandThree = P::Wellbeing.declare_new do
462     text 'During the *past 4 weeks*, have you had any of the following problems with your work or other regular daily
463         activities *as a result of your physical health?*'
464     questions(
465         Q::Rand13PhysCutWork = Q::YesNo.declare_new do
466             text 'Cut down the amount of time you spent on work or other activities'
467         end,
468         Q::Rand14PhysAccLess = Q::YesNo.declare_new do
469             text '*Accomplished less* than you would like'
470         end,
471         Q::Rand15PhysKindLimit = Q::YesNo.declare_new do
472             text 'Were limited in the *kind* of work or other activities'
473         end,
474         Q::Rand16PhysDifficultWork = Q::YesNo.declare_new do
475             text 'Had *difficulty* performing the work or other activities (for example, it took extra effort)'
476         end
477     )
478 end,
479 P::RandFour = P::Wellbeing.declare_new do
480     text 'During the *past 4 weeks*, have you had any of the following problems with your work or other regular daily
481         activities *as a result of any emotional problems* (such as feeling depressed or anxious)?'
482     questions(
483         Q::Rand17EmoCutWork = Q::YesNo.declare_new do
484             text 'Cut down the *amount of time* you spent on work or other activities'
485         end,
486         Q::Rand18EmoAccLess = Q::YesNo.declare_new do
487             text 'Accomplished less than you would like'
488         end,
489         Q::Rand19EmoLessCare = Q::YesNo.declare_new do
490             text "Didn't do work or other activities as carefully as usual"
491         end,
492         Q::Rand20InterfereSoc = Q::RadioHorizontal.declare_new do
493             text 'During the *past 4 weeks*, to what extent has your physical health or emotional problems interfered
494                 with your normal social activities with family, friends, neighbors, or groups?'
495             options [1, 'Not at all'],
496                 [2, 'Slightly'],
497                 [3, 'Moderately'],
498                 [4, 'Quite a bit'],
499                 [5, 'Extremely']
500         end,
501         Q::Rand21Pain = Q::RadioHorizontal.declare_new do
502             text 'How much *bodily* pain have you had during the *past 4 weeks?*'
503             options [1, 'None'],
504                 [2, 'Very mild'],
505                 [3, 'Mild'],
506                 [4, 'Moderate'],
507                 [5, 'Severe'],
508                 [6, 'Very severe']
509         end,
510         Q::Rand22PainInterfere = Q::RadioHorizontal.declare_new do
511             text 'During the *past 4 weeks*, how much did *pain* interfere with your normal work (including both work
512                 outside the home and housework)?'
513             options [1, 'Not at all'],
514                 [2, 'A little bit '],
515                 [3, 'Moderately'],
516                 [4, 'Quite a bit'],
517                 [5, 'Extremely']
518         end
519     )
520     progress_weight 1.5
521 end,
522 P::RandFive = P::Wellbeing.declare_new do
523     text 'These questions are about how you feel and how things have been with you *during the past 4 weeks*. For
524         each question, please give the one answer that comes closest to the way you have been feeling.'
525     text 'How much of the time during the *past 4 weeks*...?'
526     questions(
527         Q::Rand23FullPep = Q::RandTimeProp.declare_new do
528             text 'Did you feel full of enthusiasm?'
529         end,
530         Q::Rand24VeryNervous = Q::RandTimeProp.declare_new do
531             text 'Have you been a very nervous person?'
532         end,
533         Q::Rand25DownDumps = Q::RandTimeProp.declare_new do

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529     text 'Have you felt so down in the dumps that nothing could cheer you up?'
530   end,
531   Q::Rand26Calm = Q::RandTimeProp.declare_new do
532     text 'Have you felt calm and peaceful?'
533   end,
534   Q::Rand27LotEnergy = Q::RandTimeProp.declare_new do
535     text 'Did you have a lot of energy?'
536   end,
537   Q::Rand28Blue = Q::RandTimeProp.declare_new do
538     text 'Have you felt downhearted and blue?'
539   end,
540   Q::Rand29WornOut = Q::RandTimeProp.declare_new do
541     text 'Did you feel worn out?'
542   end,
543   Q::Rand30HappyPerson = Q::RandTimeProp.declare_new do
544     text 'Have you been a happy person?'
545   end,
546   Q::Rand31FeltTired = Q::RandTimeProp.declare_new do
547     text 'Did you feel tired?'
548   end
549 )
550 progress_weight 1.5
551 end,
552 P::RandSix = P::Wellbeing.declare_new do
553   questions(
554     Q::Rand32InterfereSocTime = Q::RadioHorizontal.declare_new do
555       text 'During the *past 4 weeks*, how much of the time has your *physical health or emotional problems* interfered with your social activities (like visiting with friends, relatives, etc.)?'
556       options [1, 'All of the time'],
557             [2, 'Most of the time'],
558             [3, 'Some of the time'],
559             [4, 'A little of the time'],
560             [5, 'None of the time']
561   end
562 )
563 text 'How *true* or *false* is each of the following statements for you?'
564 questions(
565   Q::Rand33SickEasy = Q::RandTrueness.declare_new do
566     text 'I seem to get sick a little easier than other people'
567   end,
568   Q::Rand34HealthyAsAnyone = Q::RandTrueness.declare_new do
569     text 'I am as healthy as anybody I know'
570   end,
571   Q::Rand35ExpectHealthWorse = Q::RandTrueness.declare_new do
572     text 'I expect my health to get worse'
573   end,
574   Q::Rand36HealthAce = Q::RandTrueness.declare_new do
575     text 'My health is excellent'
576   end
577 )
578 end,
579 P::Panas = P::Wellbeing.declare_new do
580   text 'Here are a number of words that describe different feelings and emotions.'
581   text 'For each item, please indicate to what extent you have felt this way *during the past few weeks*.'
582   questions(
583     %w(Interested Distressed Excited Upset Strong Guilty Scared Hostile Enthusiastic Proud Irritable Alert Ashamed
584       Inspired Nervous Determined Attentive Jittery Active Afraid).map do |affect|
585       Q.const_set("Panas#{affect}", Q::Panas.declare_new { text affect })
586     end
587   )
588   progress_weight 2.5
589 end,
590 # (end)
591 P::HealthLifestyle = P::Wellbeing.declare_new do
592   questions(
593     Q::Asthma = Q::YesNo.declare_new do
594       text 'Have you ever been told by a doctor that you have asthma?'
595     end,
596
597     Q::Cardiovascular = Q::YesNo.declare_new do
598       text 'Have you ever been told by a doctor that you have a heart or lung disease (other than asthma)?'
599     end,
600
601     Q::SmokeAtAll = Q::YesNo.declare_new do
602       # BHPS 2006
603       text 'Do you ever smoke cigarettes?'
604     end,
605
606     Q::SmokeAtAllAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::SmokeAtAll },
607
608     Q::SmokeNumber = Q::Radio.declare_new do
609       # BHPS 2006 -- except original question asked to enter actual number
610       show_if :condition => -> { Q::SmokeAtAll.answer == 1 },
611         :js_condition => "return <= Q::SmokeAtAll.js_instance %>.answer() == 1;",
612         :human_condition => "Please complete this question only if you answered 'Yes' above."
613       text 'How many cigarettes a day do you usually smoke, including those you roll yourself?'
614       options [1, 'Fewer than 1 a day'],
615             [2, '1 - 5 a day'],
616             [5, '5 - 14 a day'],
617             [15, '15 - 24 a day'],

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618         [25, '25 a day or more']
619     end
620   )
621
622   question_separator
623   questions(
624     Q::FruitVeg = Q::Radio.declare_new do
625       # Guidance from http://www.5aday.nhs.uk/
626       text 'How many portions of fruit and vegetables do you usually eat a day?'
627       text "Please do *not* count potatoes or grains. \n Please *do* count pure juices, tinned, frozen and dried
628         fruit and vegetables, and fruit and vegetables found in other foods.", :style => :smaller
629       options [0, 'Fewer than 1 a day'],
630             [2, '1 - 2 a day'],
631             [4, '3 - 4 a day'],
632             [5, '5 a day or more']
633     end
634   )
635
636   question_separator
637   questions(
638     Q::SleepLastNight = Q::SleepHours.declare_new do
639       text 'How much sleep did you get in the *past 24 hours*, to the nearest half hour?'
640     end,
641
642     Q::SleepGot = Q::SleepHours.declare_new do
643       text 'How much sleep do you estimate that you *typically* get, per day?'
644     end
645   )
646
647   progress_weight 2
648 end,
649 P::HomeBasics = P::Wellbeing.declare_new do
650   text "*You're over one third of the way through the survey.* We really appreciate your help.", :style => :info
651
652   text 'These questions are about the place where you usually live.'
653
654   # questions mainly from/adapted from Survey of English Housing 2004/05
655
656   questions(
657     Q::AccommType = Q::Radio.declare_new do
658       text "Is your household's accommodation..."
659       options [:house, "a house or bungalow"],
660             [:flat, "a flat or maisonette"],
661             [:room, "a room (or rooms)"],
662             [:other, "or something else?"]
663   end,
664
665     Q::HouseType = Q::Radio.declare_new do
666       show_if :condition => -> { Q::AccommType.answer == :house },
667         :js_condition => "return <%= Q::AccommType.js_instance %>.answer() == 'house';",
668         :human_condition => "Please complete this question only if you answered 'house or bungalow' above."
669
670       text 'Is the house or bungalow...'
671       options [:detached, "detached"],
672             [:semi, "semi-detached"],
673             [:terraced, "or terraced (including end-of-terrace)?"]
674   end,
675
676     Q::FlatType = Q::Radio.declare_new do
677       show_if :condition => -> { Q::AccommType.answer == :flat },
678         :js_condition => "return <%= Q::AccommType.js_instance %>.answer() == 'flat';",
679         :human_condition => "Please complete this question only if you answered 'flat or maisonette' above."
680
681       text 'Is the flat or maisonette...'
682       options [:block, "in a purpose-built block"],
683             [:conversion, "or in a converted house (or other kind of building)?"]
684   end,
685
686     Q::OtherType = Q::Radio.declare_new do
687       show_if :condition => -> { Q::AccommType.answer == :other },
688         :js_condition => "return <%= Q::AccommType.js_instance %>.answer() == 'other';",
689         :human_condition => "Please complete this question only if you answered 'something else' above."
690
691       text 'Is the accommodation...'
692       options [:mobile, "a caravan, mobile home or houseboat"],
693             [:other, "or some other kind of accommodation?"]
694   end,
695
696     Q::Tenure = Q::Radio.declare_new do
697       # Question (but not options) from Scottish House Condition Survey 1996, Q18
698
699       text 'Which of these best describes your tenure here?'
700       options [:own, 'Own outright'],
701             [:mortgage, 'Buying with the help of a mortgage or loan'],
702             [:rent, 'Rent'],
703             [:shared, 'Pay part rent and part mortgage (shared ownership)'],
704             [:rent_free, 'Live rent-free (excluding squatting)'],
705             [:squat, 'Squatting'],
706             [:other, 'Other arrangement']
707   end,

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708 Q::Landlord = Q::Radio.declare_new do
709   show_if :condition => -> { [:rent, :shared].include?(Q::Tenure.answer) },
710   :js_condition => "var a = <%= Q::Tenure.js_instance %>.answer(); return a == 'rent' || a == 'shared';
711   ",
712   :human_condition => "Please complete this question only if you answered 'Rent' or 'Pay part rent and
713   part mortgage' above."
714
715   text 'Who is your landlord?'
716   options [:council, 'The local authority (council) or New Town Development'],
717   [:ha, 'A housing association, co-operative, charitable trust or Local Housing Company'],
718   [:other, 'Any other individual or organisation']
719 end,
720
721 Q::YearsLivedHere = Q::Radio.declare_new do
722   text 'How long have you lived in this accommodation?'
723   options [0, 'Less than 12 months'],
724   [1, 'At least 12 months but less than 2 years'],
725   [2, 'At least 2 years but less than 5 years'],
726   [5, 'At least 5 years but less than 10 years'],
727   [10, 'At least 10 years but less than 20 years'],
728   [20, '20 years or longer']
729 end
730
731 P::HomeDetails = P::Wellbeing.declare_new do
732   # household definition from
733   # http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/householdestimates/
734   notesdefinitions/
735
736   text "In this survey, a *household* means:
737
738   * one person living alone, or
739   * a group of people living at the same address who share common housekeeping or a living room.", :style => :info
740
741   questions(
742     Q::HouseholdSixteenPlus = Q::Dropdown.declare_new do
743       text 'How many adults (aged 16 or over) live in your household?'
744       text "Please *include yourself.*.", :style => :smaller
745       options integer_scale 1..9
746       option [10, '10 or more']
747     end,
748
749     Q::HouseholdUnderSixteen = Q::Dropdown.declare_new do
750       text 'And how many children (aged 15 or under) live in your household?'
751       option [0, 'None']
752       options integer_scale 1..9
753       option [10, '10 or more']
754     end,
755
756     Q::HouseholdRooms = Q::Dropdown.declare_new do
757       text 'How many rooms does your household have the use of, not counting bathrooms and toilets?'
758       options integer_scale 1..9
759       option [10, '10 or more']
760     end,
761
762     Q::LivingFloor = Q::Radio.declare_new do
763       text 'On what floor of the building as a whole is your main living space?'
764       text 'If your main living space is on more than one floor, please choose the highest.', :style => :smaller
765       options [-1, 'Basement or semi-basement'],
766       [0, 'Ground floor (street level)'],
767       [1, '1st floor'],
768       [2, '2nd floor'],
769       [3, '3rd floor'],
770       [4, '4th - 9th floor'],
771       [10, '10th floor or higher']
772     end,
773
774     Q::DoubleGlazing = Q::Radio.declare_new do
775       # adapted from SoEH04/5
776       text 'Do you have double glazing?'
777       text 'Please count only factory-made sealed units.', :style => :smaller
778       options [:all, 'Yes--in all windows'],
779       [:some, 'Yes--in some windows, but not all'],
780       [:none, 'No--none']
781     end,
782
783     Q::HousingProblems = Q::Checkbox.declare_new do
784       text 'Does your home have any of the following problems?'
785       text "Please tick *all* that apply.", :style => :smaller
786       options [:mould, 'Mould growth (at least hand-sized patches) on walls or carpets'],
787       [:cold, "Heating that doesn't keep you warm enough in winter"],
788       [:draughts, 'Serious draughts due to poorly fitting windows or doors'],
789       [:insects, 'Insect infestation (e.g. moths, cockroaches, bedbugs or fleas)'],
790       [:gloom, 'Lack of natural light']
791       option_separator
792       exclusive_option [:none, 'None of the above']
793     end
794   )
795 end,
796 P::LocalArea = P::Wellbeing.declare_new do

```

```

796 questions(
797   Q::SatArea = Q::Satisfaction.declare_new do
798     text 'How satisfied are you with the area in which you live?'
799   end,
800   Q::SafetyAfterDark = Q::Radio.declare_new do
801     # ESS C6 -- options from BCS 06/07
802     text 'How safe do you -- or would you -- feel walking alone in this area after dark?'
803     options [1, 'Very safe'],
804       [2, 'Fairly safe'],
805       [3, 'A bit unsafe'],
806       [4, 'Very unsafe']
807   end,
808   Q::Neighbours = Q::Frequency.declare_new do
809     text "How often do you usually speak to your neighbours?"
810   end
811 )
812
813 question_separator
814 text 'Below are some things that can cause problems for people in their area. Which of these are problems in the
815 area where you live?'
816 questions(
817   # list adapted from Survey of English Housing 04/05 and BCS 06/07
818   Q::AirPollution = Q::ScaleOfProblem.declare_new { text 'Air pollution' },
819   Q::RoadRailNoise = Q::ScaleOfProblem.declare_new { text 'Noise from road traffic and trains' },
820   Q::AircraftNoise = Q::ScaleOfProblem.declare_new { text 'Noise from aircraft' },
821   Q::NeighbourNoise = Q::ScaleOfProblem.declare_new { text 'Noisy neighbours or loud parties' },
822   Q::Litter = Q::ScaleOfProblem.declare_new { text 'Rubbish or litter lying around' },
823   Q::Vandalism = Q::ScaleOfProblem.declare_new { text 'Vandalism or graffiti' },
824   Q::Crime = Q::ScaleOfProblem.declare_new { text 'Crime' }
825 )
826
827 progress_weight 2
828 end,
829
830 # green/nature/wildlife section (fold)
831 P::LocalGreen = P::Wellbeing.declare_new do
832   questions(
833     Q::GreenViews = Q::Checkbox.declare_new do
834       text 'Which of the following can you see from any of the windows in your home?'
835       text 'Please tick *all* that apply', :style => :smaller
836       options [:grass, 'Green space, lawns'],
837         [:trees, 'Trees'],
838         [:water, 'The sea'],
839         [:water, 'Rivers or lakes'],
840         [:pond, 'Ponds or water features'],
841         [:birdbox, 'Bird boxes or feeders']
842       option_separator
843       exclusive_option [:none, 'None of these']
844     end,
845     Q::Garden = Q::Radio.declare_new do
846       text 'Do you have a garden?'
847       options [:own, 'Yes--own garden'],
848         [:shared, 'Yes--shared with others'],
849         [:none, 'No']
850     end,
851     Q::GardenAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::Garden },
852     Q::GardenContents = Q::Checkbox.declare_new do
853       show_if :condition => -> { [:own, :shared].include?(Q::Garden.answer) },
854       :js_condition => "return ['own', 'shared'].include(<%= Q::Garden.js_instance %>.answer());",
855       :human_condition => "Please complete this question only if you answered 'Yes' above."
856       text 'Which of the following do you have in your garden?'
857       text 'Please tick *all* that apply', :style => :smaller
858       options [:grass, 'Lawns'],
859         [:trees, 'Trees'],
860         [:beds, 'Flowerbeds'],
861         [:veg, 'Fruit, vegetable or herb beds'],
862         [:pond, 'Ponds, water features'],
863         [:birdbox, 'Bird boxes or feeders']
864       option_separator
865       exclusive_option [:none, 'None of these']
866     end
867   end,
868   P::Memberships = P::Wellbeing.declare_new do
869     questions(
870       Q::NatureMember = Q::Checkbox.declare_new do
871         text 'Are you currently a member of any conservation, nature or wildlife organisations?'
872         text 'Please tick *all* that apply', :style => :smaller
873         options [:rspb, 'RSPB (the Royal Society for the Protection of Birds)'],
874           [:nt, "National Trust\nor_ National Trust for Scotland"],
875           [:cpre, "Campaign to Protect Rural England _or_ Wales\nor_ Association for the Protection of Rural
876             Scotland"],
877           [:wt, 'Woodland Trust'],
878           [:wwt, 'Wildfowl & Wetland Trust']
879       option_separator
880       option [:other, 'Other organisation(s)']
881       option_separator
882       exclusive_option [:none, 'None of these']
883     end,
884     Q::NatureMemberOther = Q::Text.declare_new do
885       show_if :condition => -> { Q::NatureMember.answer.andand.include?(:other) },

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885      :js_condition => "var a = <%= Q::NatureMember.js_instance %>.answer(); return a && a.include('other')  
886      ;",  
887      :human_condition => "Please complete this question only if you answered 'Other organisation(s)' above  
888      ."  
889      text 'Which other conservation, nature or wildlife organisation(s) are you a member of?'  
890      text_box :size => '50x2'  
891    end,  
892    Q::NatureLegacy = Q::Radio.declare_new do  
893      text 'Do you intend to leave a legacy to any conservation, nature or wildlife organisations in your Will?'  
894      options [4, 'Definitely'],  
895      [3, 'Probably'],  
896      [2, 'Probably not'],  
897      [1, 'Definitely not']  
898      option_separator  
899      option [0, "Don't know"]  
900    end  
901  )  
902 end,  
903 P::NtrspbCountry = P::Wellbeing.declare_new do  
904   questions(  
905     Q::NtCountry = Q::Oftenness.declare_new do  
906       text 'In the *past 3 months*, approximately how many times have you spent any time in countryside, coastal  
907       sites or gardens *owned by the National Trust*?'  
908       text 'Please *include* visits to National Trust properties that comprise a house and gardens where you spent  
909       some time visiting the gardens.', :style => :smaller  
910     end,  
911     Q::RspbCountry = Q::Oftenness.declare_new do  
912       text 'In the *past 3 months*, approximately how many times have you spent any time in an RSPB reserve?'  
913       text 'The RSPB is the Royal Society for the Protection of Birds.', style: :smaller  
914     end  
915   )  
916 end,  
917 P::NatParks = P::Wellbeing.declare_new do  
918   text %{  
919     !>/images/nparks.gif(Map of UK National Parks)!  
920   }  
921   The UK has 15 National Parks:  
922   * Brecon Beacons  
923   * Broads  
924   * Cairngorms  
925   * Dartmoor  
926   * Exmoor  
927   * Lake District  
928   * Loch Lomond  
929   * New Forest  
930   * Northumberland  
931   * North York Moors  
932   * Peak District  
933   * Pembrokeshire Coast  
934   * Snowdonia  
935   * South Downs  
936   * Yorkshire Dales  
937 }  
938 questions(  
939   Q::NatParks = Q::Oftenness.declare_new do  
940     text 'In the *past 3 months*, approximately how many times have you spent any time in a UK National Park?'  
941     text '%{*It's no problem if visits you include on this page overlap with those on the previous page.*  
942     For example, if you've visited National Trust gardens within a National Park, please include those visits in  
943       both totals.}', :style => :info  
944     option [:home, 'I live in a National Park']  
945     option_separator  
946   end  
947 )  
948 end,  
949 P::NatureStudy = P::Wellbeing.declare_new do  
950   text 'In the *past 3 months*, have you ...'  
951   questions(  
952     Q::Birdwatch = Q::YesNoRegularity.declare_new do  
953       text '... done any birdwatching?'  
954     end,  
955     Q::NaturePhotos = Q::YesNoRegularity.declare_new do  
956       text '... taken photos of nature/wildlife in natural habitats?'  
957     end,  
958     Q::NatureArt = Q::YesNoRegularity.declare_new do  
959       text '... spent any time drawing, painting or sculpting representations of nature/wildlife in natural  
960       habitats?'  
961   end  
962 )  
963 end,  
964 P::NatureTime = P::Wellbeing.declare_new do  
965   if [:own, :shared].include?(Q::Garden.answer)  
966     questions(  
967       Q::GardenUse = Q::Frequency.declare_new do  
968         text 'Over the *past 3 months*, how often have you typically spent any time in your *own garden*?'  
969       end,  
970       Q::GardenMoney = Q::Radio.declare_new do  
971         text 'Over the *past 3 months*, approximately how much money would you say you spent on garden products  
972         such as plants, trees and seeds, bird boxes and bird feed, and pond plants, fish or fish food?'
```

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969         option [0, 'No money']
970         options monetary_bands [:unbounded, 25, 50, 100, 250, 500, :unbounded]
971         option_separator
972         option [-99, "Don't know"]
973     end
974   )
975 end
976 questions(
977   Q::CemeteryUse = Q::Frequency.declare_new do
978     text 'Over the *past 3 months*, how often have you typically spent any time in *cemeteries or church gardens*?'
979   end,
980   Q::CountrysideUse = Q::Frequency.declare_new do
981     text 'Over the *past 3 months*, how often have you typically spent any time in *open countryside or farmland*?'
982     text %{Please *include* any visits to National Trust countryside, and to countryside within National Parks and RSPB reserves, mentioned in earlier questions.}, :style => :smaller
983   end,
984   Q::GreenSpaceUse = Q::Frequency.declare_new do
985     text 'Over the *past 3 months*, how often have you spent any time in *any other green spaces* (not listed above)?'
986     text %{These could include urban parks, recreation grounds, village greens, golf courses, and others.}, :style => :smaller
987   end
988 )
989 end,
990 P::CountryTypes = P::Wellbeing.declare_new do
991   questions(
992     Q::CountryTypes = Q::Checkbox.declare_new do
993       text 'Thinking about the time you spend in the *open countryside*, which of these habitat types would you say you *spend most time in*?'
994       text 'Please tick *up to 5*.', :style => :smaller
995       options [:coast, 'Coastal: saltmarsh, sand dunes, vegetated shingle, cliffs and slopes'],
996             [:water, 'Freshwater: rivers, lakes, ponds, reservoirs'],
997             [:wood, 'Woodland: woods and forests'],
998             [:grass, 'Grassland: meadows, pastures, grazing land'],
999             [:heath, 'Heathland: with dwarf shrubs such as heather and gorse'],
1000             [:wet, 'Wetland: marshes, fens, bogs and reedbeds'],
1001             [:up, 'Upland: hilly and mountainous areas'],
1002             [:farm, 'Farmland: land planted with crops']
1003       must_check 0..5, :message => 'Please tick no more than 5 options'
1004     end
1005   )
1006 end,
1007 skip_unless { Q::CountrysideUse.answer && Q::CountrysideUse.answer > 1 },
1008 P::MediatedNature = P::Wellbeing.declare_new do
1009   questions(
1010     Q::NatureExhib = Q::Oftenness.declare_new do
1011       text 'In the *past 12 months*, approximately how many times have you attended nature/wildlife photography exhibitions?'
1012     end,
1013     Q::NatureExhibUk = Q::Radio.declare_new do
1014       show_if :condition => -> { a = Q::NatureExhib.answer; a && a > 0 },
1015         :js_condition => "var a = #{@js_instance}.answer(); return a && a > 0;",
1016         :human_condition => "Please skip this question if you answered 'Not at all' above."
1017       text 'What proportion of the nature/wildlife pictured in those exhibitions would you estimate was in the UK?'
1018       options [4, 'All of it'],
1019             [3, 'Most of it'],
1020             [2, 'Some of it'],
1021             [1, 'A little of it'],
1022             [0, 'None of it']
1023       option_separator
1024       option [:dk, "Don't know"]
1025     end,
1026     Q::NatureMags = Q::YesNo.declare_new do
1027       text 'Do you subscribe to or regularly buy any nature/wildlife magazines?'
1028       text 'This could be BBC Wildlife magazine, National Geographic and so on.', :style => :smaller
1029     end,
1030     Q::NatureMagsUk = Q::Radio.declare_new do
1031       show_if :condition => -> { a = Q::NatureMags.answer; a && a > 0 },
1032         :js_condition => "var a = #{@js_instance}.answer(); return a && a > 0;",
1033         :human_condition => "Please skip this question if you answered 'No' above."
1034       text 'What proportion of the nature/wildlife pictured in those magazines would you estimate is in the UK?'
1035       options [4, 'All of it'],
1036             [3, 'Most of it'],
1037             [2, 'Some of it'],
1038             [1, 'A little of it'],
1039             [0, 'None of it']
1040       option_separator
1041       option [:dk, "Don't know"]
1042     end,
1043     Q::NatureTv = Q::Frequency.declare_new do
1044       text 'How often would you say you watch any nature/wildlife programmes?'
1045       text 'This could be on broadcast TV, Sky, iPlayer, DVD and so on.', :style => :smaller
1046     end
1047   )
1048 end,
1049 P::NatureBbc = P::Wellbeing.declare_new do
1050   questions(
1051     Q::NatureBbc = Q::Radio.declare_new do

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```

1052     text 'In the *past 12 months*, approximately how much time in total have you spent watching BBC TV programmes
1053         featuring *nature/wildlife in the UK* (such as Springwatch, Autumnwatch, Coast, Wild Wales, and so on)
1054         ?'
1055     text 'These could have been on broadcast TV, iPlayer or DVD.', :style => :smaller
1056     options [0, 'No time'],
1057         [1, 'Up to 6 hours (30 mins per month)'],
1058         [2, 'Up to 12 hours (1 hour per month)'],
1059         [3, 'Up to 24 hours (2 hours per month)'],
1060         [4, 'Up to 36 hours (3 hours per month)'],
1061         [5, 'Up to 48 hours (4 hours per month)'],
1062         [6, 'More than 48 hours']
1063     option_separator
1064     option [:dk, "Don't know"]
1065 end,
1066 Q::NatureLicenceFee = Q::Radio.declare_new do
1067     text 'How much would you be willing to pay as part of your current BBC licence fee for such programmes to be
1068         made?'
1069     options [0, 'Nothing'],
1070         *monetary_bands([:unbounded, 1, 2, 5, 10, 20, 50, 75, 100, :unbounded], :pennies => true)
1071     option_separator
1072     option [:dk, "Don't know"]
1073 end
1074
1075 # (end)
1076 # IPAQ (fold)
1077 P::IpaqIntro = P::Wellbeing.declare_new do
1078     text 'The next few pages will ask about the time you spent being physically active in the *last 7 days*. Please
1079         answer each question even if you do not consider yourself to be an active person.'
1080     text 'Please think about the activities you do at work, as part of your house and yard work, to get from place to
1081         place, and in your spare time for recreation, exercise or sport.'
1082     text 'Think about all the *vigorous* and *moderate* activities that you did in the *last 7 days*.
1083
1084     * *Vigorous* physical activities refer to activities that take hard physical effort and make you breathe much
1085         harder than normal.
1086     * *Moderate* activities refer to activities that take moderate physical effort and make you breathe somewhat
1087         harder than normal.', style: :info
1088 questions(
1089     Q::IpaqJob = Q::YesNo.declare_new do
1090         text 'Do you currently have a job or do any unpaid work outside your home?'
1091         text 'This *includes* paid jobs, farming, volunteer work, course work, and any other unpaid work that you did
1092             outside your home. *Do not include* unpaid work you might do around your home, like housework, yard
1093             work, general maintenance, and caring for your family.', style: :smaller
1094     end
1095 )
1096 end,
1097 P::IpaqWork = P::Wellbeing.declare_new do
1098     text 'The next questions are about all the physical activity you did in the *last 7 days* as part of your paid or
1099         unpaid work. This does not include travelling to and from work.'
1100 questions(
1101     Q::IpaqWorkVigourDays = Q::Radio.declare_new do
1102         text 'During the *last 7 days*, on how many days did you do *vigorous* physical activities like heavy lifting
1103             , digging, heavy construction, or climbing up stairs *as part of your work*? Think about only those
1104             physical activities that you did for at least 10 minutes at a time.'
1105         option [1, '1 day per week']
1106         options *(2..7).map { |d| [d, "#{d} days per week"] }
1107         option_separator
1108         option [0, 'No vigorous job-related activity']
1109     end,
1110     Q::IpaqWorkVigourTime = Q::TimePerDay.declare_new do
1111         show_if :condition => -> { Q::IpaqWorkVigourDays.answer != 0 },
1112             :js_condition => "return <%= Q::IpaqWorkVigourDays.js_instance %>.answer() != '0';",
1113             :human_condition => "Please skip this question if you answered 'No vigorous job-related activity'
1114                 above."
1115         text 'How much time did you usually spend on one of those days doing *vigorous* physical activities as part
1116             of your work?'
1117     end
1118 )
1119 question_separator
1120 questions(
1121     Q::IpaqWorkModDays = Q::Radio.declare_new do
1122         text 'Again, think about only those physical activities that you did for at least 10 minutes at a time.
1123             During the *last 7 days*, on how many days did you do *moderate* physical activities like carrying
1124                 light loads *as part of your work*? Please do not include walking.'
1125         option [1, '1 day per week']
1126         options *(2..7).map { |d| [d, "#{d} days per week"] }
1127         option_separator
1128         option [0, 'No moderate job-related activity']
1129     end,
1130     Q::IpaqWorkModTime = Q::TimePerDay.declare_new do
1131         show_if :condition => -> { Q::IpaqWorkModDays.answer != 0 },
1132             :js_condition => "return <%= Q::IpaqWorkModDays.js_instance %>.answer() != '0';",
1133             :human_condition => "Please skip this question if you answered 'No moderate job-related activity'
1134                 above."
1135         text 'How much time did you usually spend on one of those days doing *moderate* physical activities as part
1136             of your work?'
1137     end
1138 )
1139 question_separator
1140 questions(

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```

1125 Q::IpaqWalkModDays = Q::Radio.declare_new do
1126   text 'During the *last 7 days*, on how many days did you *walk* for at least 10 minutes at a time *as part of
1127     your work? Please do not count any walking you did to travel to or from work.'
1128   option [1, '1 day per week']
1129   options *(2..7).map { |d| [d, "#{d} days per week"] }
1130   option_separator
1131   option [0, 'No job-related walking']
1132 end,
1133 Q::IpaqWalkModTime = Q::TimePerDay.declare_new do
1134   show_if :condition => -> { Q::IpaqWalkModDays.answer != 0 },
1135     :js_condition => "return <%= Q::IpaqWalkModDays.js_instance %>.answer() != '0';",
1136     :human_condition => "Please skip this question if you answered 'No job-related walking' above."
1137   text 'How much time did you usually spend on one of those days *walking* as part of your work?'
1138 end
1139 )
1140 skip_unless { Q::IpaqJob.answer == 1 },
1141 P::IpaqTravel = P::Wellbeing.declare_new do
1142   text 'These questions are about how you traveled from place to place, including to places like work, shops,
1143     movies, and so on.'
1144   questions(
1145     Q::IpaqTravelMotorDays = Q::Radio.declare_new do
1146       text 'During the *last 7 days*, on how many days did you *travel in a motor vehicle* like a train, bus, car
1147         or tram?'
1148       option [1, '1 day per week']
1149       options *(2..7).map { |d| [d, "#{d} days per week"] }
1150       option_separator
1151       option [0, 'No travelling in a motor vehicle']
1152     end,
1153     Q::IpaqTravelMotorTime = Q::TimePerDay.declare_new do
1154       show_if :condition => -> { Q::IpaqTravelMotorDays.answer != 0 },
1155         :js_condition => "return <%= Q::IpaqTravelMotorDays.js_instance %>.answer() != '0';",
1156         :human_condition => "Please skip this question if you answered 'No travelling in a motor vehicle'
1157           above."
1158       text 'How much time did you usually spend on one of those days *travelling* in a train, bus, car, tram, or
1159             other kind of motor vehicle?'
1160     end
1161   )
1162   text 'Now think only about the *bicycling and walking* you might have done to travel to and from work, to do
1163     errands, or to go from place to place.'
1164   questions(
1165     Q::IpaqTravelBikeDays = Q::Radio.declare_new do
1166       text 'During the *last 7 days*, on how many days did you *bicycle* for at least 10 minutes at a time to go *
1167         from place to place?'
1168       option [1, '1 day per week']
1169       options *(2..7).map { |d| [d, "#{d} days per week"] }
1170       option_separator
1171       option [0, 'No bicycling from place to place']
1172     end,
1173     Q::IpaqTravelBikeTime = Q::TimePerDay.declare_new do
1174       show_if :condition => -> { Q::IpaqTravelBikeDays.answer != 0 },
1175         :js_condition => "return <%= Q::IpaqTravelBikeDays.js_instance %>.answer() != '0';",
1176         :human_condition => "Please skip this question if you answered 'No bicycling from place to place'
1177           above."
1178       text 'How much time did you usually spend on one of those days to bicycle from place to place?'
1179     end
1180   )
1181   question_separator
1182   questions(
1183     Q::IpaqTravelWalkDays = Q::Radio.declare_new do
1184       text 'During the *last 7 days*, on how many days did you *walk* for at least 10 minutes at a time to go *from
1185         place to place?'
1186       option [1, '1 day per week']
1187       options *(2..7).map { |d| [d, "#{d} days per week"] }
1188       option_separator
1189       option [0, 'No walking from place to place']
1190     end,
1191     Q::IpaqTravelWalkTime = Q::TimePerDay.declare_new do
1192       show_if :condition => -> { Q::IpaqTravelWalkDays.answer != 0 },
1193         :js_condition => "return <%= Q::IpaqTravelWalkDays.js_instance %>.answer() != '0';",
1194         :human_condition => "Please skip this question if you answered 'No walking from place to place' above
1195           ."
1196       text 'How much time did you usually spend on one of those days *walking* from place to place?'
1197     end
1198   )
1199 end,
1200 P::IpaqHome = P::Wellbeing.declare_new do
1201   text 'This section is about some of the physical activities you might have done in the *last 7 days* in and
1202     around your home, like housework, gardening, yard work, general maintenance work, and caring for your
1203     family.'
1204   questions(
1205     Q::IpaqGardenVigourDays = Q::Radio.declare_new do
1206       text 'Think about only those physical activities that you did for at least 10 minutes at a time. During the *
1207         last 7 days*, on how many days did you do *vigorous* physical activities like heavy lifting, chopping
1208         wood, shoveling snow, or digging *in the garden or yard*?'
1209       option [1, '1 day per week']
1210       options *(2..7).map { |d| [d, "#{d} days per week"] }
1211       option_separator
1212       option [0, 'No vigorous activity in garden or yard']
1213     end,
1214     Q::IpaqGardenVigourTime = Q::TimePerDay.declare_new do

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1202     show_if :condition => -> { Q::IpaqGardenVigourDays.answer != 0 },
1203         :js_condition => "return <%= Q::IpaqGardenVigourDays.js_instance %>.answer() != '0';",
1204         :human_condition => "Please skip this question if you answered 'No vigorous activity in garden or
1205             yard' above."
1206         text 'How much time did you usually spend on one of those days doing *vigorous* physical activities in the
1207             garden or yard?'
1208     end
1209 )
1210 question_separator
1211 questions(
1212     Q::IpaqGardenModDays = Q::Radio.declare_new do
1213         text 'Again, think about only those physical activities that you did for at least 10 minutes at a time.
1214             During the *last 7 days*, on how many days did you do *moderate* activities like carrying light loads,
1215                 sweeping, washing windows, and raking *in the garden or yard*?'
1216         option [1, '1 day per week']
1217         options *(2..7).map { |d| [d, "#{d} days per week"] }
1218         option_separator
1219         option [0, 'No moderate activity in garden or yard']
1220     end,
1221     Q::IpaqGardenModTime = Q::TimePerDay.declare_new do
1222         show_if :condition => -> { Q::IpaqGardenModDays.answer != 0 },
1223             :js_condition => "return <%= Q::IpaqGardenModDays.js_instance %>.answer() != '0';",
1224             :human_condition => "Please skip this question if you answered 'No moderate activity in garden or
1225                 yard' above."
1226         text 'How much time did you usually spend on one of those days doing *moderate* physical activities in the
1227             garden or yard?'
1228     end
1229 )
1230 question_separator
1231 questions(
1232     Q::IpaqHomeModDays = Q::Radio.declare_new do
1233         text 'Once again, think about only those physical activities that you did for at least 10 minutes at a time.
1234             During the *last 7 days*, on how many days did you do *moderate* activities like carrying light loads,
1235                 washing windows, scrubbing floors and sweeping *inside your home*?'
1236         option [1, '1 day per week']
1237         options *(2..7).map { |d| [d, "#{d} days per week"] }
1238         option_separator
1239         option [0, 'No moderate activity inside home']
1240     end,
1241     Q::IpaqHomeModTime = Q::TimePerDay.declare_new do
1242         show_if :condition => -> { Q::IpaqHomeModDays.answer != 0 },
1243             :js_condition => "return <%= Q::IpaqHomeModDays.js_instance %>.answer() != '0';",
1244             :human_condition => "Please skip this question if you answered 'No moderate activity inside home'
1245                 above."
1246         text 'How much time did you usually spend on one of those days doing *moderate* physical activities inside
1247             your home?'
1248     end
1249 )
1250 end,
1251 P::IpaqLeisure = P::Wellbeing.declare_new do
1252     text 'This section is about all the physical activities that you did in the *last 7 days* solely for recreation,
1253         sport, exercise or leisure.'
1254     text 'Please do not include any activities you have already mentioned.', style: :info
1255     questions(
1256         Q::IpaqLeisureWalkDays = Q::Radio.declare_new do
1257             text 'Not counting any walking you have already mentioned, during the *last 7 days*, on how many days did you
1258                 walk for at least 10 minutes at a time *in your leisure time*?'
1259             option [1, '1 day per week']
1260             options *(2..7).map { |d| [d, "#{d} days per week"] }
1261             option_separator
1262             option [0, 'No walking in leisure time']
1263         end,
1264         Q::IpaqLeisureWalkTime = Q::TimePerDay.declare_new do
1265             show_if :condition => -> { Q::IpaqLeisureWalkDays.answer != 0 },
1266                 :js_condition => "return <%= Q::IpaqLeisureWalkDays.js_instance %>.answer() != '0';",
1267                 :human_condition => "Please skip this question if you answered 'No walking in leisure time' above."
1268             text 'How much time did you usually spend on one of those days *walking* in your leisure time?'
1269         end,
1270         Q::IpaqLeisureWalkGreen = Q::AmountOfThisTime.declare_new do
1271             show_if :condition => -> { Q::IpaqLeisureWalkDays.answer != 0 },
1272                 :js_condition => "return <%= Q::IpaqLeisureWalkDays.js_instance %>.answer() != '0';",
1273                 :human_condition => "Please skip this question if you answered 'No walking in leisure time' above."
1274             text 'And for how much of this time you spent walking in your leisure time were you out *in the countryside
1275                 or other green spaces*?'
1276         end
1277     )
1278     question_separator
1279     questions(
1280         Q::IpaqLeisureVigourDays = Q::Radio.declare_new do
1281             text 'Think about only those physical activities that you did for at least 10 minutes at a time. During the *
1282                 last 7 days*, on how many days did you do *vigorous* physical activities like aerobics, running, fast
1283                     bicycling, or fast swimming *in your leisure time*?'
1284             option [1, '1 day per week']
1285             options *(2..7).map { |d| [d, "#{d} days per week"] }
1286             option_separator
1287             option [0, 'No vigorous activity in leisure time']
1288         end,
1289         Q::IpaqLeisureVigourTime = Q::TimePerDay.declare_new do
1290             show_if :condition => -> { Q::IpaqLeisureVigourDays.answer != 0 },
1291                 :js_condition => "return <%= Q::IpaqLeisureVigourDays.js_instance %>.answer() != '0';",

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1277         :human_condition => "Please skip this question if you answered 'No vigorous activity in leisure time'
1278         above."
1279     text 'How much time did you usually spend on one of those days doing *vigorous* physical activities in your
1280         leisure time?'
1281     end,
1282     Q::IpaqLeisureVigourGreen = Q::AmountOfThisTime.declare_new do
1283         show_if :condition => -> { Q::IpaqLeisureVigourDays.answer != 0 },
1284             :js_condition => "return <%= Q::IpaqLeisureVigourDays.js_instance %>.answer() != '0';",
1285             :human_condition => "Please skip this question if you answered 'No vigorous activity in leisure time'
1286             above."
1287     text 'And for how much of this time you spent doing vigorous activity in your leisure time were you out *in
1288         the countryside or other green spaces*?'
1289     end
1290   )
1291   question_separator
1292   questions(
1293     Q::IpaqLeisureModDays = Q::Radio.declare_new do
1294         text 'Again, think about only those physical activities that you did for at least 10 minutes at a time.
1295             During the *last 7 days*, on how many days did you do *moderate* physical activities like bicycling at
1296             a regular pace, swimming at a regular pace, and doubles tennis in your *leisure time*?'
1297         option [1, '1 day per week']
1298         options *(2..7).map { |d| [d, "#{d} days per week"] }
1299         option_separator
1300         option [0, 'No moderate activity in leisure time']
1301     end,
1302     Q::IpaqLeisureModTime = Q::TimePerDay.declare_new do
1303         show_if :condition => -> { Q::IpaqLeisureModDays.answer != 0 },
1304             :js_condition => "return <%= Q::IpaqLeisureModDays.js_instance %>.answer() != '0';",
1305             :human_condition => "Please skip this question if you answered 'No moderate activity in leisure time'
1306             above."
1307     text 'How much time did you usually spend on one of those days doing *moderate* physical activities in your
1308         leisure time?'
1309     end,
1310     Q::IpaqLeisureModGreen = Q::AmountOfThisTime.declare_new do
1311         show_if :condition => -> { Q::IpaqLeisureModDays.answer != 0 },
1312             :js_condition => "return <%= Q::IpaqLeisureModDays.js_instance %>.answer() != '0';",
1313             :human_condition => "Please skip this question if you answered 'No moderate activity in leisure time'
1314             above."
1315     text 'And for how much of this time you spent doing moderate physical activites in your leisure time were you
1316         out *in the countryside or other green spaces*?'
1317     end,
1318   )
1319   P::IpaqSitting = P::Wellbeing.declare_new do
1320     text 'These questions are about the time you spend sitting while at work, at home, while doing course work and
1321         during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or
1322         lying down to watch television.'
1323     text 'Do not include any time spent sitting in a motor vehicle that you have already mentioned.', style: :info
1324     questions(
1325       Q::IpaqSittingWeekdayTime = Q::TimePerDay.declare_new do
1326         text 'During the *last 7 days*, how much time did you usually spend *sitting* on a *weekday*?'
1327       end,
1328       Q::IpaqSittingWeekendTime = Q::TimePerDay.declare_new do
1329         text 'During the *last 7 days*, how much time did you usually spend *sitting* on a *weekend day*?'
1330       end
1331     )
1332   end,
1333 # (end)
1334
1335 P::OtherPlace = P::Wellbeing.declare_new do
1336   questions(
1337     Q::OtherPlaceType = Q::Radio.declare_new do
1338       text 'Apart from your home, in what single location do you spend most time?'
1339       options [:work, 'Workplace'],
1340           [:study, 'Place of study'],
1341           [:other, 'Other location']
1342       option_separator
1343       option [:none, 'No single location']
1344     end,
1345
1346     Q::OtherPlaceTypeAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::OtherPlaceType },
1347
1348     Q::OtherPlaceOther = Q::Text.declare_new do
1349       show_if :condition => -> { Q::OtherPlaceType.answer == :other },
1350           :js_condition => "return <%= Q::OtherPlaceType.js_instance %>.answer() == 'other';",
1351           :human_condition => "Please complete this question only if you answered 'Other location' above."
1352
1353       text 'What is this other location?'
1354       text_box :size => '30x1'
1355     end
1356   )
1357   progress_weight 0.5
1358 end,
1359 P::OtherPlaceDetails = P::Wellbeing.declare_new do
1360
1361   place_descriptor = case Q::OtherPlaceType.answer
1362     when :work then 'workplace'
1363     when :study then 'place of study'
1364     else          'other location'
1365   end

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1356
1357     questions(
1358         Q::OtherPostcode = Q::Postcode.declare_new do
1359
1360             text "What is the full postcode of your #{place_descriptor}?"
1361
1362             completion :prompted
1363             prompted_completion_message "You don't have to give a postcode here, but we'd really appreciate it if you did
1364             , since location characteristics are key to our research."
1365         end,
1366
1367         Q::CommuteTime = Q::Radio.declare_new do
1368             text "About how much time does it usually take for you to get to your #{place_descriptor} each day, door to
1369             door?"
1370             options [5, 'Less than 15 minutes'],
1371                 [20, '15 - 29 minutes'],
1372                 [40, '30 - 44 minutes'],
1373                 [60, '45 - 59 minutes'],
1374                 [80, 'An hour or more']
1375         end,
1376         Q::CommuteMeans = Q::Checkbox.declare_new do
1377             text "Which of these means of transport do you usually use to travel to and from your #{place_descriptor}?"
1378             text 'Please tick *all* that apply.', :style => :smaller
1379             options [:rail, 'Train (above ground)'],
1380                 [:tube, 'Underground train (tube, metro)'],
1381                 [:bus, 'Bus, minibus or coach (public or private)'],
1382                 [:mbike, 'Motorcycle, scooter or moped'],
1383                 [:driver, 'Driving a car or van'],
1384                 [:driven, 'Passenger in a car, van or taxi'],
1385                 [:bike, 'Bicycle'],
1386                 [:walk, 'Walking (or running) _for at least 5 minutes_']
1387             option_separator
1388             exclusive_option [:none, 'None of the above']
1389         end
1390     )
1391
1392     question_separator
1393     questions(
1394         Q::OtherPlaceFloor = Q::Radio.declare_new do
1395             text "On what floor of the building as a whole do you spend most time in your #{place_descriptor}?"
1396             options [-1, 'Basement or semi-basement'],
1397                 [0, 'Ground floor (street level)'],
1398                 [1, '1st floor'],
1399                 [2, '2nd floor'],
1400                 [3, '3rd floor'],
1401                 [4, '4th - 9th floor'],
1402                 [10, '10th floor or higher']
1403             option_separator
1404             option [:na, 'No single floor']
1405         end,
1406
1407         Q::OtherGreenViews = Q::Checkbox.declare_new do
1408             text "Which of the following can you usually see from inside your #{place_descriptor}?"
1409             text 'Please tick *all* that apply.', :style => :smaller
1410             options [:grass, 'Green space, lawns'],
1411                 [:trees, 'Trees'],
1412                 [:water, 'The sea'],
1413                 [:water, 'Rivers or lakes'],
1414                 [:pond, 'Ponds or water features'],
1415                 [:birdbox, 'Bird boxes or feeders']
1416             option_separator
1417             exclusive_option [:none, 'None of these']
1418         end,
1419         skip_unless { Q::OtherPlaceType.answer && Q::OtherPlaceType.answer != :none },
1420         P::Groups = P::Wellbeing.declare_new do # ESS E1 - E3
1421             text 'Please take a moment to think of any groups, clubs or organisations you take part in. These could be youth
1422             groups, sports clubs or pub teams, religious groups, evening classes, choirs, book groups, or any other
1423             groups, clubs or organisations.'
1424         questions(
1425             Q::ClubsGroupsEtc = Q::EssFrequency.declare_new do
1426                 text 'In the past 12 months, how often did you take part in all groups, clubs or organisations like this
1427                 combined?'
1428             end
1429         )
1430         question_separator
1431         questions(
1432             Q::EssVoluntaryOrgs = Q::EssFrequency.declare_new do # ESS E1
1433                 text 'In the past 12 months, how often did you get involved in work for voluntary or charitable organisations
1434                 ?'
1435             end,
1436             Q::EssLocalActivities = Q::EssFrequency.declare_new do # ESS E3
1437                 text 'And in the past 12 months, how often did you help with or attend activities organised in your local
1438                 area?'
1439             end
1440         )
1441         question_separator
1442         questions(
1443             Q::CarOwnership = Q::Radio.declare_new do
1444                 text 'Is there a car or van normally available for use by you or any members of your household?'

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1440     options [2, 'Yes--a privately owned car or van'],
1441     [1, 'Yes--a car club car or van'],
1442     [0, 'No']
1443   end
1444 )
1445 end,
1446 P::Demographics = P::Wellbeing.declare_new do
1447   questions(
1448     Q::MaritalStatus = Q::Radio.declare_new do
1449       text 'What is your marital status?'
1450       text 'Please choose the *first* option that applies. For all response options, please treat *Civil Partnership* as equivalent to marriage.', :style => :smaller
1451       options [:single, 'Single (never married--but may be in a relationship)'],
1452         [:married, 'Married and living with your husband or wife'],
1453         [:separated, 'Married and separated from your husband or wife'],
1454         [:divorced, 'Divorced'],
1455         [:widowed, 'Widowed']
1456   end,
1457
1458   Q::InCoupleOrRel = Q::Radio.declare_new do
1459     show_if :condition => -> { [:single, :separated, :divorced, :widowed].include?(Q::MaritalStatus.answer) },
1460     :js_condition => "return $A(['single', 'separated', 'divorced', 'widowed']).include(<%= Q::MaritalStatus.js_instance %>.answer());",
1461     :human_condition => 'Please complete the following question only if you answered "Single", "Married and separated", "Divorced", or "Widowed" above.'
1462
1463     text 'And are you currently...'
1464     options [2, 'living with someone as a couple, or'],
1465       [1, 'in a relationship with someone, but not living together, or'],
1466       [0, 'neither of the above?']
1467   end,
1468
1469   Q::AnyChildren = Q::Radio.declare_new do
1470     text 'Do you have any children?'
1471     options [2, 'Yes--more than one'],
1472       [1, 'Yes--one'],
1473       [0, 'No--none']
1474   end,
1475
1476   Q::AnyChildrenAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::AnyChildren },
1477
1478   Q::ChildOfAge = Q::Radio.declare_new do
1479     show_if :condition => -> { Q::AnyChildren.answer == 1 },
1480     :js_condition => "return <%= Q::AnyChildren.js_instance %>.answer() == 1;",
1481     :human_condition => "Please complete the following question only if you answered 'Yes--one' above."
1482
1483     text "What is your child's age?"
1484     option [0, 'Under 2 years']
1485     options discrete_numeric_bands [2, 5, 11, 16, 21, :unbounded],
1486       :top_unbounded => 'or over'
1487   end,
1488
1489   Q::ChildrenOfAges = Q::Checkbox.declare_new do
1490     show_if :condition => -> { Q::AnyChildren.answer == 2 },
1491     :js_condition => "return <%= Q::AnyChildren.js_instance %>.answer() == 2;",
1492     :human_condition => "Please complete the following question only if you answered 'Yes--more than one' above."
1493
1494     text "What are your children's ages?"
1495     text "Please tick *all* that apply.", :style => :smaller
1496     option [0, 'Under 2 years']
1497     options discrete_numeric_bands [2, 5, 11, 16, 21, :unbounded],
1498       :top_unbounded => 'or over'
1499   end,
1500
1501   Q::Qualifications = Q::Radio.declare_new do
1502     text 'What qualifications do you have?'
1503     text 'These may be educational, professional, vocational or other work-related qualifications.', :style => :
1504       smaller
1505     options [2, 'Qualifications at degree level or above'],
1506       [1, 'Qualifications below degree level'],
1507       [0, 'No qualifications']
1508   end,
1509 )
1510 end,
1511 P::Income = P::Wellbeing.declare_new do
1512   text "*The wellbeing effect of income, relative to other factors, is an important part of our research*, so we would be very grateful for your answers here. Please be assured that your information is confidential."
1513
1514   Remember that in this survey a *household* means:
1515
1516   * one person living alone, or
1517   * a group of people living at the same address who share common housekeeping or a living room.", :style => :info
1518
1519   questions(
1520     Q::HouseholdIncome = Q::Income.declare_new do
1521       text %Q{What is your *household's* total gross annual income? This is:
1522
1523       * for all household members,
1524       * from all sources (earnings, benefits, investments, etc.), and
1525       * before taxes and National Insurance.}

```

```

1525
1526     completion :prompted, :message => "*You don't have to give an answer here, but we would really appreciate it
1527         if you did.* The wellbeing effect of income relative to other factors is one of the key issues in our
1528         research."
1529     end,
1530
1531     Q::IndividualIncome = Q::Income.declare_new do
1532         text %Q{And what is your own *individual* total gross annual income? Again, this is:
1533
1534         * from all sources (earnings, benefits, investments, etc.), and
1535         * before taxes and National Insurance.}
1536
1537     completion :prompted, :message => "*You don't have to give an answer here, but we would really appreciate it
1538         if you did.* The wellbeing effect of income relative to other factors is one of the key issues in our
1539         research."
1540     end
1541 )
1542
1543     progress_weight 0.5
1544 end,
1545 P::ReligionPolitics = P::Wellbeing.declare_new do
1546     # all questions verbatim from ESS: C22, 23
1547
1548     questions(
1549         Q::HowReligious = Q::ScaleHorizontal.declare_new do
1550             text 'Regardless of whether you belong to a particular religion, how religious would you say you are?'
1551             scale :range => 0..10,
1552                 :start => "Not at all \n religious",
1553                 :end => "Very \n religious"
1554         end,
1555
1556         Q::ReligiousServices = Q::ReligiousFrequency.declare_new do
1557             text 'Apart from special occasions such as weddings and funerals, about how often do you attend religious
1558             services nowadays?'
1559         end
1560     )
1561
1562     question_separator
1563     questions(
1564         Q::PoliticalInterest = Q::RadioHorizontal.declare_new do
1565             text 'How interested would you say you are in politics?'
1566             options [4, 'Not at all interested'],
1567                 [3, 'Hardly interested'],
1568                 [2, 'Quite interested'],
1569                 [1, 'Very interested']
1570         end,
1571
1572         Q::PoliticsLeftRight = Q::ScaleHorizontal.declare_new do
1573             text 'In politics people sometimes talk of "left" and "right". Where would you place yourself on this scale?'
1574             scale :range => 0..10,
1575                 :start => 'Left',
1576                 :end => 'Right',
1577                 :others => [[:dk, '', "Don't know"]]
1578         end
1579     )
1580
1581     P::FamilyBackground = P::Wellbeing.declare_new do
1582         text 'These questions are about you and your family when you were growing up.'
1583
1584         # Questions mainly adapted from National Survey of Sexual Attitudes and Lifestyles 2000
1585
1586         assumed_still_home = Q::Age.answer && Q::Age.answer.to_i < 16
1587
1588         questions(
1589             Q::Siblings = Q::Radio.declare_new do
1590                 text 'Do you have, or did you have, any *brothers or sisters*?'
1591                 text 'Please include adopted and half brothers and sisters.', :style => :smaller
1592                 options [2, 'Yes--more than one'],
1593                     [1, 'Yes--one'],
1594                     [0, 'No--none']
1595         end,
1596
1597             Q::SiblingsAnswerHistory = Q::AnswerHistory.declare_new { monitor Q::Siblings },
1598
1599             Q::NaturalParents = Q::Radio.declare_new do
1600                 text assumed_still_home ?
1601                     'Have you lived more or less continuously with *both* of your natural (birth) parents in the same home?' :
1602                         'Did you live more or less continuously with *both* of your natural (birth) parents in the same home until
1603                         you were 16?'
1604
1605                 text "If you #{assumed_still_home ? 'have' : ''} lived with your natural parents except when away at a
1606                     boarding school or for other temporary periods, please answer 'Yes'.", :style => :smaller
1607
1608                 options [1, 'Yes'],
1609                     [0, 'No'],
1610                     [:na, 'Prefer not to answer']
1611
1612             completion :optional
1613         end,
1614
1615     end,
1616
1617     completion :optional
1618
1619 end,

```

```

1609     Q::WhyNotNaturalparents = Q::Radio.declare_new do
1610       show_if :condition => lambda { Q::NaturalParents.answer == 0 },
1611         :human_condition => "Please complete this question only if you answered 'No' above.",
1612         :js_condition => "return <%= Q::NaturalParents.js_instance %>.answer() == 0;"
1613
1614       text "Why #{assumed_still_home ? 'is' : 'was'} this?"
1615       options [:split, 'There was a divorce or separation'],
1616         [:death, 'There was a death'],
1617         [:adopted, 'I was adopted'],
1618         [:never_together, 'My parents never lived together'],
1619         [:other, 'Another reason'],
1620         [:na, 'Prefer not to answer']
1621
1622       completion :optional
1623     end
1624   )
1625 end,
1626 P::Shocks = P::Wellbeing.declare_new do
1627   question(
1628     Q::Shocks = Q::Checkbox.declare_new do
1629       text 'Have you suffered any of the following *in the last year*?'
1630       text 'Please tick *all* that apply.', :style => :smaller
1631       options [:unemployment, 'Compulsory redundancy'],
1632         [:bankruptcy, 'Bankruptcy'],
1633         [:repossession, 'Repossession of your home'],
1634         [:bereavement, 'Death of a loved one'],
1635         [:divorce, 'Separation or divorce from your spouse'],
1636         [:othercrime, 'Theft or fraud'],
1637         [:violentcrime, 'Violent crime']
1638       option_separator
1639       exclusive_option [:none, 'None of the above']
1640     end
1641   )
1642   progress_weight 0.5
1643   forward_prompt 'Finish and submit answers &#187;'
1644 end,
1645 P::TolunaCompletion = P::Redirect.declare_new do
1646   completes_survey true
1647   destination_url (RAILS_ENV == 'production' ? 'http://ups.surveymruter.com/SurveyTrafficUI/STMUI/socompleted.aspx?' :
1648     ' : 'http://www.google.com/search?q=completed')
1649   skip_unless { toluna_respondent_cond.call },
1650   P::Thanks.declare do
1651     title 'Thank you'
1652     text contents_of_file 'thanks_text.txt'
1653     suppress_backward true
1654     completes_survey true
1655     progress_weight 0
1656     help_page nil
1657   end
1658 )
1659 end

```

Appendix B

Supplementary information for experience sampling methods

B.1 Surveys

The surveys span multiple screens, delineated below by horizontal rules. Tapping an option suffixed by '>' immediately advances to the next screen. The first screen has a 'Cancel' button that discontinues the questionnaire, and each subsequent screen has a 'Back' button to return to the preceding screen.

B.1.1 Registration survey

Satisfaction

How satisfied are you with your life as a whole nowadays?

Segmented control: (Not at all) 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 (Extremely)

Next >

Health

Is your health in general... ?

Excellent >

Very good >

Good >

Fair >

Poor >

Asthma

Do you suffer from asthma or other respiratory disease?

Yes >

No >

Gender

Are you... ?

Male >

Female >

Birth year

When were you born?

Scrolling picker: 1900 – 2010 (initial position: 1975)

Next >

Marriage

Are you... ?

Never married >

Married and living with spouse >

Married but separated >

Divorced >

Widowed >

Please choose the first that applies, and treat Civil Partnership like marriage

THIS SCREEN IS NOT SHOWN IF THE PARTICIPANT ANSWERED 'MARRIED AND LIVING WITH SPOUSE' ABOVE

Relationship

And are you currently in a relationship?

Yes >

No >

Work status

Are you... ?

Employed or self-employed >

In full-time education >

Retired >

Unemployed and seeking work >

Long-term sick or disabled >

Looking after family or home >

Other >

Adults

In your household, including yourself, are there... ?

- 1 adult >
- 2 adults >
- 3 adults >
- 4 adults or more >

Please count as adults those aged 16 or above

Income change

Compared to 3 years ago, is your gross annual household income now... ?

- Higher than it was >
 - Just the same >
 - Lower than it was >
 - Don't know >
 - Prefer not to say >
-

Children

In your household, are there... ?

- No children >
- 1 child >
- 2 children >
- 3 children >
- 4 children or more >

Please count as children those aged 15 or under

THIS SCREEN IS SHOWN ONLY IF THE PARTICIPANT ANSWERED 'HIGHER THAN IT WAS' ABOVE

Income rise

And finally, compared to 3 years ago, is your gross annual household income now... ?

- Higher by up to £999 >
- Higher by £1,000 – £1,999 >
- Higher by £2,000 – £3,999 >
- Higher by £4,000 – £7,999 >
- Higher by £8,000 – £15,999 >
- Higher by £16,000 or more >

Don't know >

Prefer not to say >

Household

Is your gross annual household income from all sources... ?

- Under £8,000 >
- £8,000 – £11,999 >
- £12,000 – £15,999 >
- £16,000 – £19,999 >
- £20,000 – £23,999 >
- £24,000 – £31,999 >
- £32,000 – £39,999 >
- £40,000 – £55,999 >
- £56,000 – £71,999 >
- £72,000 – £95,999 >
- £96,000 or more >

Don't know >

Prefer not to say >

We'd be very grateful if you could answer this question, since it's important to our research

THIS SCREEN IS SHOWN ONLY IF THE PARTICIPANT ANSWERED 'LOWER THAN IT WAS' ABOVE

Income fall

And finally, compared to 3 years ago, is your gross annual household income now... ?

- Lower by up to £999 >
- Lower by £1,000 – £1,999 >
- Lower by £2,000 – £3,999 >
- Lower by £4,000 – £7,999 >
- Lower by £8,000 – £15,999 >
- Lower by £16,000 or more >

Don't know >

Prefer not to say >

THE QUESTIONNAIRE DISMISSES ITSELF IMMEDIATELY AFTER THIS SCREEN IS DISPLAYED

Finished

Thank you!

B.1.2 ESM survey

Feelings

Do you feel... ?

Happy

Slider: Not at all ... Extremely (initial position: midpoint)

Relaxed

Slider: Not at all ... Extremely (initial position: midpoint)

Awake

Slider: Not at all ... Extremely (initial position: midpoint)

Next >

People

Please tick all that apply

Are you... ?

Alone, or with strangers only >

Or are you with your... ?

Spouse, partner, girl/boyfriend

Children

Other family members

Colleagues, classmates

Clients, customers

Friends

Other people you know

Next >

Place

Are you... ?

Indoors >

Outdoors >

In a vehicle >

Place (2)

And are you... ?

At home >

At work >

Elsewhere >

If you're working from home, please choose 'At home'

TAPPING 'ADD OR EDIT NOTES' DISPLAYS A TEXT ENTRY AREA WITH KEYBOARD — THE PARTICIPANT TAPS 'DONE' WHEN FINISHED TO RETURN TO THIS SCREEN

Activities

Please tick all that apply

Just now, what were you doing?

Working, studying

In a meeting, seminar, class

Travelling, commuting

Cooking, preparing food

Housework, chores, DIY

Admin, finances, organising

Shopping, errands

Waiting, queueing

Childcare, playing with children

Pet care, playing with pets

Care or help for adults

Sleeping, resting, relaxing

Sick in bed

Meditating, religious activities

Washing, dressing, grooming

Intimacy, making love

Talking, chatting, socialising

Eating, snacking

Drinking tea/coffee

Drinking alcohol

Smoking

Texting, email, social media

Browsing the Internet

- Watching TV, film
- Listening to music
- Listening to speech/podcast
- Reading
- Theatre, dance, concert
- Exhibition, museum, library
- Match, sporting event
- Walking, hiking
- Sports, running, exercise
- Gardening, allotment
- Birdwatching, nature watching
- Hunting, fishing
- Computer games, iPhone games
- Other games, puzzles
- Gambling, betting
- Hobbies, arts, crafts
- Singing, performing
- Something else

Add or edit notes

Next >

BY DEFAULT, THIS DIGITAL CAMERA SCREEN IS SHOWN ONLY WHEN OUTDOORS

Please take a photo straight ahead

Or tap Cancel to skip this step

THIS SCREEN IS SHOWN ONLY IF A PHOTO WAS TAKEN

Map

Add this photo to the public map?

Yes >

No >

THIS SCREEN IS SHOWN ONLY WHEN OUTDOORS AND IN THE RARE EVENT THAT GPS LOCATION ACCURACY IS STILL WORSE THAN 100M. IT ADVANCES AUTOMATICALLY WHEN ACCURACY REACHES 100M OR 60 SECONDS HAS ELAPSED.

Location

Improving location accuracy

Skip >

THE QUESTIONNAIRE DISMISSES ITSELF IMMEDIATELY AFTER THIS SCREEN IS DISPLAYED

Finished

Thank you!

B.2 Data server implementation details

B.2.1 Database

At the heart of the data server is a PostgreSQL relational database system with PostGIS spatial extensions¹. The Mappiness database schema (presented in section B.3) consists of five key tables:

users stores administrative details at participant (app) level: each row maps to one past or current registered installation of the Mappiness app on a participant's iPhone. Details stored include the participant ID number and authentication secret for that app installation, the participant's beep settings, and the 'device token' identifying the installation to Apple's push notification servers.

demographic_answer_sets also contains one row per registered app installation. It holds the participant's answers to the survey presented during the registration process, and is linked to the relevant row of the users table.

esm_answer_sets has one row per participant response. It holds the participant's answers, and links to the relevant row of the users table and (where applicable) the **sent_beeps** table. It does not hold contributed photographs, which are instead stored within the file system.

pending_beeps & **sent_beeps** support the beeper system. The former is a transient store of signals that will be sent in the next 24 hours, while the latter records details of all signals sent. Both are linked to the relevant rows of the users table.

B.2.2 Signalling

B.2.2.1 The Apple Push Notifications Service (APNS)

Apps for Apple's iOS can make use of the Apple Push Notifications Service (APNS). This service enables an app provider to send a notification to an app user's device. APNS notifications operate, and appear to device users, in a manner very similar to SMS text messages, but can be sent at no cost to sender or recipient. Notifications are sent via APNS servers operated by Apple.²

A notification can be delivered at any time the target device is available — that is, powered on and connected to the Internet — whether or not the relevant app is open. If the device is available, a notification is usually delivered within a few seconds; if it is not, the notification is queued for delivery at the next opportunity. Delivery of notifications "is 'best effort' and is not guaranteed" (Apple Inc., 2010c, p. 31), although testing indicates that the vast majority of notifications are delivered successfully.

If an app provider attempts to send a notification to an app which no longer exists on the target device, the device reports this to the APNS, which updates an app-specific list of devices for which there were failed delivery attempts. App providers are obliged to query a feedback service regularly to retrieve this list, and to refrain from sending future notifications to the listed devices unless they are subsequently re-registered.

B.2.2.2 Communicating with the APNS

Mappiness uses APNS notifications to signal participants. Communicating with the APNS requires use of a proprietary binary protocol over a persistent, authenticated connection. Managing such a connection is somewhat technically demanding, and Mappiness therefore relies on intermediary software.

¹<http://www.postgresql.org/> and <http://postgis.refractions.net/>

²Late in the development of the Mappiness app a new version of the iPhone operating system, iOS 4, introduced Local Notifications. Local Notifications are scheduled by an app itself. Local Notifications would have some advantages over Push Notifications — chiefly, that they would not require an active data connection, and so could be received at any location. Used alone, they would also have disadvantages — no more than 64 Local Notifications may be scheduled, and if the app is not opened before these expire then no more notifications can be received.

Initially, the free tier of a commercial service operated by Urban Airship, Inc.³ was used. This service connects to the APNS on behalf of app providers, and is controlled via a simple API⁴ that sends and receives data using JSON⁵ messages over HTTPS⁶. However, the volume of notifications to be sent rapidly approached the usage limits of the free service tier.

After evaluating various alternatives we therefore installed an additional open-source software package on the Mappiness data server: PyAPNS⁷. Like the Urban Airship service, PyAPNS handles all communication with the APNS and is controlled by a simple API. The PyAPNS API communicates over XML-RPC⁸, but also provides a Ruby client library to encapsulate this communication. The Mappiness signalling software was rewritten to use the PyAPNS client library (to which we also contributed several fixes).

B.2.2.3 Signalling using APNS

Signalling is performed by the signalling programme on the Mappiness data server. The programme is executed every 2 minutes, and on each execution performs the following sequence of tasks:

1. (This task is only performed if it has not been performed in the past hour). Connect to the APNS feedback service to retrieve a list of app installations with failed deliveries. Mark all listed installations inactive in the users database table, and delete any pending signals associated with them from the pending_beeps table.
2. For each participant who has reached the end of signalling hours since the last programme execution, calculate the signalling schedule for the next day according to the algorithm described in subsection 5.3.1. Similarly, for each participant who has changed their beep settings since last programme execution, recalculate the signalling schedule for the remaining hours of this day⁹ or the next day. Store the resulting pending signals in the pending_beeps table.
3. For each signal in the pending_beeps table that has fallen due since the last programme execution, delete the pending signal, send an APNS notification to the associated participant, and create a record of the sent signal in the sent_beeps table.

B.2.2.4 Safeguards

Foreseeable failure modes of the signalling system could antagonise participants. For example, participants might be woken from sleep if they were signalled outside the hours they have specified, or feel harassed and irritated if they were signalled many times over a short period. In such cases, the reputation of the project — and its ability to recruit and keep participants — could be damaged.

The signalling system was therefore implemented defensively, to try to prevent such failures. For example, the system considers the hours during which a participant may be beeped as finishing 10 minutes prior to the time specified by the participant, to account for possible delays in notification delivery. It deletes pending signals from the database prior to attempting their delivery, so that multiple deliveries will not be attempted if an error occurs during the delivery or deletion phase. And it refuses to proceed (and emails the system administrator) if more than a certain number of signals appear to fall due at one moment.

³<http://urbanairship.com/products/push-notifications/>

⁴Application Programming Interface: a documented interface that enables one computer program or system to communicate with another.

⁵JavaScript Object Notation: a concise, text-based data format.

⁶HyperText Transfer Protocol Secure: the encrypted protocol used to transmit secure web pages.

⁷<https://github.com/samuraisam/pyapns/>

⁸eXtensible Markup Language Remote Procedure Call: a verbose, text-based protocol for sending and receiving API messages.

⁹If settings are changed during the (potentially newly set) hours of the participant's signalling day, the number of signals to be sent during the remainder of the day is calculated on a probabilistic *pro rata* basis. For example, a participant who selects to receive 3 signals per day half-way through a day is theoretically due 1.5 signals during the remainder of the day. He or she will thus certainly be sent 1 signal, and will be sent a second with a probability of 50%.

B.2.3 Data API

The Mappiness app communicates with the data server via the private data API. The data API is a web application that receives and sends JSON messages over an encrypted HTTPS connection. It is written using the Sinatra framework for Ruby and served by the Phusion Passenger module for the nginx web server (all open-source).¹⁰ The data API makes the following nine endpoints available to the app:

register is called on completion of the participant sign-up process. The app sends details of the APNS device token required for sending signals to the registering device, and of the participant's confirmed signalling settings (both of which are stored in the users table). It also sends the participant's answers to the registration survey (which are stored in demographic_answer_sets). In response, the API returns a unique participant ID and a random 20-character secret. The app stores these, and uses them to authenticate itself (using HTTP Basic authentication) for all future API requests.

esm_answers is called with new ESM assessment responses, which are stored in the esm_answer_sets table. The API also links the response set with the signal it was given in response to (if applicable) in the sent_beeps table.

image is called with the JPEG image data resulting from a photo taken during an ESM assessment, and a code identifying the associated ESM assessment. The image is stored in the filesystem. If it was marked as public, it is also made accessible via a URL within the public website.

user_status is called on app launch or when there are no further ESM assessment responses queued for sending to the API. The API calculates and returns the response statistics alongside a status message to be displayed on the main screen.

graphs_bluff is called when the participant taps the 'My happiness' control. The API returns instructions for displaying the participant's feedback charts (using the Bluff¹¹ charting library for JavaScript) as an HTML+CSS+JavaScript document.

settings is called when the participant changes his or her signalling settings. The new settings are stored in the users table.

toggle_download is called when the participant enables or disables data download. When enabling data download, the API returns the new, secret HTTPS URL via which the participant's data may be accessed.

update_token is called if the app detects that its APNS device token has changed. The message includes the new device token, which is stored in the users table.

apn_ignored is called in the rare case that the app is open and receives an APNS notification that cannot be displayed because another modal activity is in progress (such as completing an ESM assessment, or changing signalling settings). The API flags the relevant notification in the sent_beeps database table to indicate that it should not count towards the total signals received by the participant.¹²

B.2.3.1 Asynchronous endpoint priorities

Four of the API endpoints listed above are handled asynchronously by the Mappiness app. In other words, communication with these endpoints occurs in the background, without blocking other app functions. These endpoints are: update_token, esm_answers, image, and apn_ignored.

The app manages a single queue of messages to the asynchronous endpoints. If the queue is not empty and no asynchronous message is currently being transmitted, the app will begin sending the message at the head of the queue. Reflecting the importance of different endpoints to the data collection process, the message queue is ordered by endpoint priority. The endpoints are listed in the preceding paragraph in descending priority order. For example, all ESM assessment response data will be transmitted before any image is sent. Messages for the same endpoint are processed in first-in-first-out order.

¹⁰<http://www.sinatrarb.com/>, <http://www.modrails.com/> and <http://nginx.org/>

¹¹<http://bluff.jcoglan.com/>

¹²The signal is not rescheduled, so the participant receives fewer than the scheduled number of signals on the day in question.

B.2.4 Security and backup

Security against intrusions is essential for participants' privacy and for the integrity of the collected data. The data servers are firewalled to prevent access to any services but the Mappiness data services (over HTTP and HTTPS) and a secure shell (SSH) for system administration. SSH access is restricted to the researcher's IP addresses¹³. All installed software is updated regularly to ensure that known exploits are patched.

To guard against the loss of collected data in case of intrusion, hardware failure or other disaster, an offsite backup is performed daily. The backup is made in the early hours of the morning (UK time), when load on the server is at its lowest. The server backup script invokes the open-source Duplicity software¹⁴ to back up the contents of the database, and all photos, weather and pollution data, to the Amazon Simple Storage Service (S3).¹⁵ S3 provides durable and redundant data storage across multiple devices and physical locations. To comply with Data Protection Act requirements, backup data is stored only on S3 servers located within the EU. Backups are encrypted, and also transmitted over an encrypted connection.

Full backups are performed monthly. The daily backups occurring in between are incremental: only changes relative to the previous backup are transmitted and stored. Each backup creates a snapshot, so that the data that was held on the server on any particular day may be restored as needed.¹⁶ To verify that data is being backed up correctly, data for analysis is retrieved not directly from the production server, but from the latest backup instead. This strategy also reduces load on the production server.

B.2.5 Web statistics

The public Mappiness web site has four elements that require up-to-date statistics from the production data server. These are:

- a count at the bottom of every page of the total number of participants that have signed up;
- a map of the most recent 120 responses where the 'happy' self-rating was at least 70%, and a photo was taken and allowed to be displayed;
- 'hedonometers' displaying the average and current happiness ratings for London and the whole of the UK — these are the mean values of respectively all responses and the 25 most recent responses; and
- a chart showing the mean happiness response for the UK and London, hour-by-hour during the past week — excluding any hours for which there were fewer than 10 responses.

Statistics for the hour-by-hour chart are calculated every hour, and statistics for the others are calculated every 5 minutes, by scripts executed on the appropriate schedule. The statistics are saved (in JSON format) in a directory publicly accessible over an HTTP connection, and are loaded as required from the public website.

B.2.6 Download API

As an additional incentive, participants are able to access all of their own contributed data.¹⁷ The data download feature is initially disabled for each participant, and it can be enabled and disabled within the app. When it is enabled, the participant's data is available via a secure

¹³Internet Protocol (IP) addresses identify the networks and computers from which data sent across the Internet originate.

¹⁴<http://duplicity.nongnu.org/>

¹⁵<http://aws.amazon.com/s3/>

¹⁶Snapshots are crucial to the effectiveness of backup. Without snapshots, corruption or deletion of data on the server is quickly mirrored to the backup, rendering it useless.

¹⁷This feature was added with the launch of version 1.1 of the app in May 2011.

(HTTPS) link. To ensure privacy, this link cannot be guessed — it includes 8 random characters — and it changes each time the download feature is enabled.¹⁸

Data download is made available by another web application built using the Sinatra framework. Several formats are supported:

HTML reproducing the charts available within the app (which can then be emailed, saved or printed), providing a gallery of the photos submitted by the participant, and displaying all responses on an interactive map.

KMZ for exploration within mapping applications such as Google Earth.

iCalendar for viewing (and subscribing to) within calendaring applications such as iCal.

XLS and CSV for import into spreadsheet or statistics applications, for subsequent graphing or statistical analysis.

JSON for consumption by third-party services. For example, services could be developed to display a personal 'hedonometer' on a participant's own blog, to post details of responses to a participant's Twitter or Facebook account, or to provide a participant with more detailed analysis of his or her responses.

For all formats except HTML charts, response data are provided in descending order of response date/time, and the web application accepts query parameters limiting the data to be returned by date/time and by position in the response sequence.

B.2.7 Weather & pollution

Every hour, weather data is downloaded from Weather Underground¹⁹, and air pollution data is downloaded from Defra²⁰. These data are stored for later processing.

B.3 PostgreSQL database schema

```
1  create table users(
2    id          bigserial      primary key,
3
4    hashed_secret   character varying(40) ,
5    device_token    character varying(64) ,
6    token_updated_at timestamp without time zone ,
7
8    active        boolean       not null default true,
9
10   created_at     timestamp without time zone not null default localtimestamp,
11   marked_inactive_at timestamp without time zone ,
12   superseded_at  timestamp without time zone ,
13
14   beeps_per_day  smallint      not null default 2,
15   beeps_not_before time without time zone not null default '08:00',
16   beeps_not_after time without time zone not null default '22:00',
17   beeps_sound    character varying(32) not null default 'ding',
18
19   beeps_recalculate_after timestamp without time zone not null default '2001-01-01',
20
21   data_secret    character varying(24)
22 ) with (oids = false);
23 create index recalculate_after_idx on users (beeps_recalculate_after);
24
25 create table pending_beeps(
26   id          bigserial      primary key,
27   user_id     bigint        not null references users,
28   send_after  timestamp without time zone not null
29 ) with (oids = false);
```

¹⁸The link is of the form <https://mappiness.me/xxxx.yyyy.yyyy> — for example, <https://mappiness.me/3kkq.pk7d.23wb>. The xxxx component encodes the participant's ID, while the yyyy.yyyy component is a random eight-character string, displayed in two groups of four characters for ease of reading. The xs and ys can be any digit (0–9) or lower-case letter (a–z) except the following: 0, 1, a, e, i, o, u, l (vowels are excluded to ensure that offensive words cannot be generated, and 0, 1, i, o and l are excluded because they are easily visually confused). The 8-character string can therefore take any of 28^8 (approximately 378 billion) values.

¹⁹<http://www.wunderground.com/global/UK.html>

²⁰<http://uk-air.defra.gov.uk/latest/currentlevels?type=Current>

```

30  create index beep_schedule_idx on pending_beeps (send_after);
31  create index beep_user_idx on pending_beeps (user_id);
32
33  create table sent_beeps(
34      id                      bigserial          primary key,
35      user_id                 bigint            not null references users,
36      send_after               timestamp without time zone not null,
37      sent_at                 timestamp without time zone not null,
38      sound                   character varying(32) not null,
39      ignored                 boolean           not null default false
40  ) with (oids = false);
41  create index beep_sent_at_idx on sent_beeps (sent_at);
42  create index beep_sent_user_idx on sent_beeps (user_id);
43
44  create table esm_answer_sets (
45      id                      bigserial          primary key,
46      user_id                 bigint            not null references users,
47      ip_addr                 inet,
48
49      answers_json             text              ,
50
51      _start                  timestamp without time zone ,
52      _img_id                 integer           ,
53      _has_pic                boolean           ,
54
55      pic_received             boolean           default 'f',
56      pic_landscape            boolean           ,
57
58      _badge                  smallint          ,
59      _apnsdata                character varying(32) ,
60
61      feel_hpy                real              ,
62      feel_rlx                real              ,
63      feel_awk                real              ,
64
65      place                   character varying(8) ,
66      place2                  character varying(8) ,
67
68      public                  boolean           ,
69
70      vol_pk_max               real              ,
71      vol_ave_mean              real              ,
72
73      vol_pk_90                real              ,
74      vol_ave_50                real              ,
75
76      sent_beep_id             bigint           references sent_beeps
77  ) with (oids = false);
78  select addgeometrycolumn('esm_answer_sets', 'location', 4326, 'point', 3); -- 4326 = wgs84
79  create index esm_user_idx on esm_answer_sets (user_id);
80  create index esm_start_idx on esm_answer_sets (_start);
81  create index esm_img_id_idx on esm_answer_sets (_img_id);
82  create index esm_beep_id_idx on esm_answer_sets (sent_beep_id);
83
84  create table esm_duplicates (
85      id                      bigserial          primary key,
86      user_id                 bigint            not null references users,
87      _img_id                 integer           ,
88      answers_json             text              ,
89  ) with (oids = false);
90  create index esmdup_user_idx  on esm_duplicates (user_id);
91  create index esmdup_img_id_idx on esm_duplicates (_img_id);
92
93  create table demographic_answer_sets(
94      id                      bigserial          primary key,
95      user_id                 bigint            not null references users,
96      answers_json             text              ,
97  ) with (oids=false);

```

B.4 Press release

PRESS RELEASE

For immediate release: 16 August 2010

"Mapping happiness? There's an app for that"

LSE researchers launch iPhone app to track UK's happiness across space and time

Mappiness, an iPhone app mapping happiness across the UK, is officially launched today at the London School of Economics. The project will help researchers understand how people's feelings are affected by their immediate environment – including features such as pollution, noise, weather conditions and green space.

The app, which is the first of its kind, pings users daily to ask how they're feeling, and uses satellite positioning (GPS) to discover their location while they answer. Response locations are linked to environmental data, which will be fed into statistical models of wellbeing.

Lead researcher George MacKerron, of LSE's Department of Geography & Environment, said: "tracking happiness through time alone is an idea with history: in the 19th century economists imagined a 'hedonometer', a perfect happiness gauge, and psychologists have more recently run small-scale 'experience sampling' studies to see how mood varies with activity, time of day, and so on."

"What's exciting here is the addition of the spatial dimension. By tracking across space as well as time, and by making novel use of a technology that millions of people already carry with them, we hope to find better answers to questions about the impacts of natural beauty, environmental problems – maybe even aspects of climate – on individual and national wellbeing."

Professor Lord Richard Layard, Director of the Well-being Programme at LSE's Centre for Economic Performance, said: "Mappiness is a revolutionary research idea. It is the best method so far devised for understanding how people's emotions are affected by the buildings and natural environment in which they move".

National happiness levels are updated in real-time on the project website, www.mappiness.org.uk, alongside maps and timelines derived from the response data. App users also get access to personalised charts analysing their own mood in return for taking part.

Mappiness is a free download on Apple's online App Store. The researchers aim to get at least 3,000 people joining in the project. All iPhone owners are invited to take part.

Notes for editors

* The researchers behind the app are George MacKerron and Dr Susana Mourato, environmental economists in the Department of Geography & Environment at the London School of Economics and Political Science (LSE).

* This official launch follows a one-week technical pilot.

* The 'mappiness' app beeps users at random moments one or more times a day. It asks how 'happy', how 'relaxed' and how 'awake' they feel using sliding scales. It also asks for brief contextual information – on activity, companionship and location – which is needed as a control. Users who are outdoors can optionally contribute a photo. While users answer, location is determined using satellite positioning (GPS) and noise levels are measured using the iPhone's microphone. All data is sent back – wirelessly, anonymously and securely – to a central data store.

* Ongoing app updates are planned. For example, users will in future be able to download all their own data – as spreadsheet and Google Earth files – to analyse for themselves.

* Details and resources are available at <http://www.mappiness.org.uk/> – including real-time happiness meters, a three-day national happiness index chart, and a photo-map of the happiest locations in the UK.

* Print- and screen-ready artwork is available on request.

Contact

George MacKerron
g.j.mackerron@lse.ac.uk
020 7193 7369
07917 735 567

B.5 App Store description

mappiness maps happiness across space in the UK. It's part of a research project at the London School of Economics. We'd love to have you on board!

*** NOTE: If you're not in the UK, please see <http://www.mappiness.org.uk/> for an important message about time zones ***

HOW DOES IT WORK?

- You download the app, open it, and sign up
- We beep you once (or more) a day to ask how you're feeling, and a few basic things to control for: who you're with, where you are, what you're doing (if you're outdoors, you can also take a photo)
- The data gets sent back — anonymously and securely — to our data store, along with your approximate location from the iPhone's GPS, and a noise-level measure

WHAT'S IN IT FOR YOU?

- Interesting information about your own happiness, which is charted inside the app and available for private download — including when, where and with whom you're happiest
- The warm glow of helping increase the sum of human knowledge

WHAT'S IN IT FOR US?

- We're particularly interested in how people's happiness is affected by their local environment — air pollution, noise, green spaces, and so on — which the data from mappiness will be absolutely great for investigating
- We hope to have some results published in academic journals, and elsewhere — whatever we produce will be linked from our website, <http://www.mappiness.org.uk>

FIND OUT MORE

For more information, visit <http://www.mappiness.org.uk>, or download the app, open it, and choose 'Find out more'.

B.6 Website

The following pages show the site as it appeared on 12 May 2011.

[Open Feedback Dialog](#)



[Home](#) [News](#) [Meters](#) [Maps](#) [More info](#)

mappiness maps happiness across space in the UK

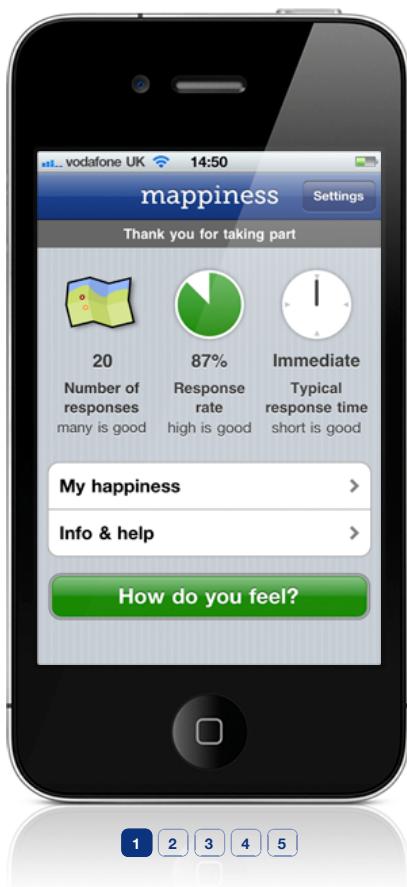
mappiness is a free app for your iPhone

It's part of a research project at the London School of Economics

We'd love to have you on board!

how does it work?

- You [get mappiness from the App Store](#), open it, and sign up
- We beep you once (or more) a day to ask how you're feeling, and a few basic things to control for: who you're with, where you are, what you're doing (if you're outdoors, you can also take a photo)
- The data gets sent back — anonymously and securely — to our data store, along with your approximate location from the iPhone's GPS, and a noise-level measure



what's in it for you?

- Interesting information about your own happiness, which you can download or see charted inside the app — including when, where and with whom you're happiest
- The warm glow of helping increase the sum of human knowledge

what's in it for us?

- We're particularly interested in how people's happiness is affected by their local environment — air pollution, noise, green spaces, and so on — which the data from mappiness will be absolutely great for investigating
- We hope to have results published in academic journals and elsewhere — whatever we produce will be linked from here

[get the app](#)

[tell me more](#)

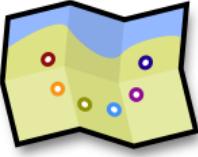
[Share](#) 1429 [Tweet](#) 1 [Digg](#) [reddit this!](#)

We have **41,260** participants. We'd love more. Please share!

[Open Feedback Dialog](#)

LSE

mappiness.org.uk



Available on the App Store

Home News Meters Maps More info

tweeted

@[mappiness_app](#)
#[mappiness](#)

BridgetGC I love the idea of the Hedonimeter! <http://www.mappiness.org...>
3 days ago · reply · retweet · favorite

crescentmen RT @BridgetGC: Where are you and are you happy? Join <http://www.mappiness.org...> research project
3 days ago · reply · retweet · favorite

fab830 @YannickNet tu parlais d'une application Iphone avec dan qui s'appelle mappiness ou ma pe... Lol !!!
2 days ago · reply · retweet · favorite

AshleyJablow Where and when are we at our happiest? Interesting study based on an iPhone app! <http://bit.ly/fjFCC>
yesterday · reply · retweet · favorite

Join the conversation

blogged

Keep up to date by subscribing to [our research blog](#). Is Blue Monday a myth? Where are mappiness users located? [And more...](#)



TEDxBrighton 2010, 'Reasons to be cheerful'
Mapping happiness across space and time

| 17 February 2011



[also on YouTube \(works on iPhone/iPad/iPod\)](#) and [on the TEDxBrighton website](#)

as seen on tv

On BBC One, BBC News Channel and BBC World News
Click

| 16 October 2010

mappiness features on Click, the BBC's flagship technology programme
[see it on the BBC website](#) (15.45 – 16.30)

From Reuters
The app that maps happiness

| 13 October 2010



[see it on the Reuters website](#) — or [watch in Spanish on BBC Mundo](#)

On CNN's Connect The World
App to map happiness

| 2 September 2010



[also on the CNN website](#)

on the radio

On BBC Radio 4
Click On

| 11 April 2011

Researcher George MacKerron discusses the mappiness project with Simon Cox
[listen to the interview](#) (23.34 – 28.46)

On NPR
Marketplace Morning Report

| 5 April 2011

"Happiness is just a smartphone app away" with David Brancaccio
[listen to the interview](#) or [see the transcript](#)

On News/Talk WJR 760am
The Paul W Smith Show

| 20 October 2010

"There's an app for that": Paul W speaks to researcher George MacKerron
[listen to the interview](#)

On BBC Radio 2

| 11 October 2010

Simon Mayo Drivetime

Lead researcher George MacKerron talks to Rebecca Pike about mappiness' preliminary findings

[hear it via BBC iPlayer until 17 Oct 2010](#) (1:35.20 – 1:37.58)

On BBC Radio 5 live
5 Live Drive

| 11 October 2010

mappiness researcher George MacKerron discusses the happiest days of the week with 5 Live Drive's Peter Allen

[hear it via BBC iPlayer until 17 Oct 2010](#) (26.50 – 29.10)

On the BBC World Service
Newshour

| 11 October 2010

Is Tuesday the new Monday? James Coomarasamy quizzes mappiness researcher George MacKerron

[hear it via BBC iPlayer](#) (50.00 – 53.00)

On BBC local radio
Drivetime and breakfast shows

| 2010 & 2011

mappiness has also featured on BBC local radio in Scotland, the West Midlands, Berkshire, Kent, Lancashire, Solent and Sussex

in the press

In the Wall Street Journal
The Really Smart Phone

| 23 April 2011

Researchers are harvesting a wealth of intimate detail from our cellphone data, uncovering the hidden patterns of our social lives

[read more in the Wall Street Journal](#)

In the Observer

| 13 February 2011

George MacKerron: 'I can measure how happy you are – and why'

George MacKerron is the inventor of Mappiness, an iPhone app that collates information from thousands of people to find out when, where and why we are at our happiest

[read more in the Observer](#)

In the Vancouver Sun

| 12 February 2011

How the smart phone can help you do the right thing

Good sustainability decisions are so much easier to make because of emerging connectivity media

[read more in the Vancouver Sun](#)

On the front page of Le Figaro!

| 12 October 2010

Le mardi est déprimant, foi de Britanniques (Tuesday is depressing, say British)

Le lundi, en dépit de sa sinistre réputation, ne serait pas le jour le plus haïssable de la semaine. À en croire des chercheurs de la London School of Economics (LSE), c'est plutôt aux mardis qu'une majorité de la population britannique réservera ses humeurs les plus sombres.

[see the story \(in French\) in Le Figaro](#)

In the Daily Mail

| 12 October 2010

Forget manic Monday, terrible Tuesday is really the most depressing day of the week

If you woke up this morning thinking the toughest day of the week had been and gone, you were wrong. Mondays may have long been thought of as miserable, but we're more likely to feel down in the dumps on a Tuesday.

[read more in the Daily Mail](#)

In the Telegraph

| 11 October 2010

Mondays less miserable than Tuesdays, research finds

Bob Geldof famously sang about his dislike of Mondays, but it appears that most people find Tuesday the most miserable day of the week.

[read more in the Telegraph](#)

In the Daily Mail

| 11 October 2010

Tuesday is the day we hate most and Slough makes people miserable

When Bob Geldof wrote his hit song I Don't Like Mondays, it became an anthem for every office worker who enjoy their fun-filled weekends and hate the beginning of the week and back to the daily grind. Now a survey using smartphone technology has revealed that Tuesday and not Monday is the day most people feel miserable.

[read more in the Daily Mail](#)

In the Sunday Times

| 10 October 2010

Get the app, join the happy map

An experiment by the London School of Economics has charted the "emotional index" of the nation, as volunteers keep a track of their emotional states using smartphone technology.

[read more in the Sunday Times \(paywalled\)](#)

In the Independent

| 2 October 2010

The 50 best apps

mappiness makes the Independent's top ten in this round-up of the best iPhone apps.

[see it in the Independent](#)

From Mary Ormsby in the Toronto Star

| 17 August 2010

Happy? Touch this.

Remember when Lucy hugged Snoopy and happiness was a warm puppy? Now, that feel-good state is defined by data bouncing off satellites.

[read more in the Toronto Star](#)

In the Telegraph

| 16 August 2010

Apple iPhone to 'map happiness'

Mappiness officially launches today, and aims to help researchers understand how people's feelings are affected by their immediate environment. Pollution, noise, weather conditions and green space will be among the factors that data will be compared against.

[read more in the Telegraph](#)

and elsewhere

On Mark Prigg's Evening Standard blog | 16 August 2010
Tracking Britain's happiness via mobile phones

Researchers at the London School of Economics and Political Science have launched a new iPhone app designed to track how happy the UK is.

[read more in the Evening Standard](#)

In the Independent on Sunday | 15 August 2010
The secret of happiness: Family, friends and your environment

In an attempt to better understand how people's feelings are affected by their immediate environment researchers from the London School of Economics will tomorrow launch a "mappiness" project, which aims to track British happiness. Using a free iPhone app, researchers will ask users how they feel at regular intervals, using GPS to pinpoint their location.

[read more in the Independent](#)

From Oran Parker's blog | 19 January 2011
Just how happy are you? "Mappiness" can help you find the answer

What makes this app ultimately work for me is that it's not heavy. It's easy to set up, and easy to use. Also, it's being used for a positive purpose, and helps remind me to constantly ask, "Oran, are you happy?"

[read more on Oran's blog](#)

On the 'healthier, happier, more productive' blog | 18 November 2010
Mappiness

Happiness research may seem easy to criticise. How can we get reliable data? Will participants answer honestly in a survey? If they are filling the survey at school or work how does that environment affect their feelings and answers? ... Some of these problems might just have been solved by combining smart-phones and surveys.

[read more at 'healthier, happier, more productive'](#)

At Vervacious | 1 September 2010
On mappiness and happiness

If you haven't caught up with it yet, it's what can only be described as serious fun: an attempt to map different daily levels of happiness linked by iPhone satnav to where you are on the UK map.

[read more at Vervacious](#)

At discovery.com's Planet Green | 23 August 2010
Mappiness iPhone App Pinpoints Happy Places

It's commonly thought that if we're happy, we make those around us happier too; conversely, if those around us are happy, we feel happier along with them. So what if you could stake out where the happiest places are located and go there -- or let people know where we're happiest so they can join in? UK researchers are hoping to uncover environmental factors in what makes people happy, and are using one of the most handy tools available -- iPhones.

[read more at Planet Green](#)

At Fast Company

| 18 August 2010

Mappiness iPhone App Measures Happiness in the UK

A pair of researchers from the London School of Economics' Department of Geography & Environment are measuring happiness throughout the UK. And to do it, they've created an iPhone app called Mappiness.

[read more at Fast Company](#)

From Parmy Olson at Forbes

| 18 August 2010

Dr. iPhone's Happiness App

PhD students are smart, but George MacKerron is in a class of his own. As part of the final year of his research at the London School of Economics, MacKerron, 31, has found a novel way of collecting data for his doctorate: an iPhone application.

[read more at Forbes](#)

On TechCrunch

| 16 August 2010

Mappiness iPhone App Maps Happiness (Say That Three Times Fast)

Officially launching today is Mappiness, a UK iPhone app that "maps Happiness" by pinging users with a survey in order to plot out their feelings during the day.

[read more on TechCrunch](#)

Richard Layard

| 13 August 2010

"A revolutionary research idea"

Professor Lord [Richard Layard](#), Director of the [Well-being Programme](#) at LSE's Centre for Economic Performance, says:

Mappiness is a revolutionary research idea. It is the best method so far devised for understanding how people's emotions are affected by the buildings and natural environment in which they move.

On the nef blog

| 10 August 2010

Real-time happiness data launched for the UK

Having downloaded the app a few days ago I can report that responding is more fun and less onerous than it might sound – and the personal stats it generates provides a really interesting insight in to when and how my mood has been changing.

[read more on the nef blog](#)



We have **41,260** participants. We'd love more. Please share!

[Open Feedback Dialog](#)

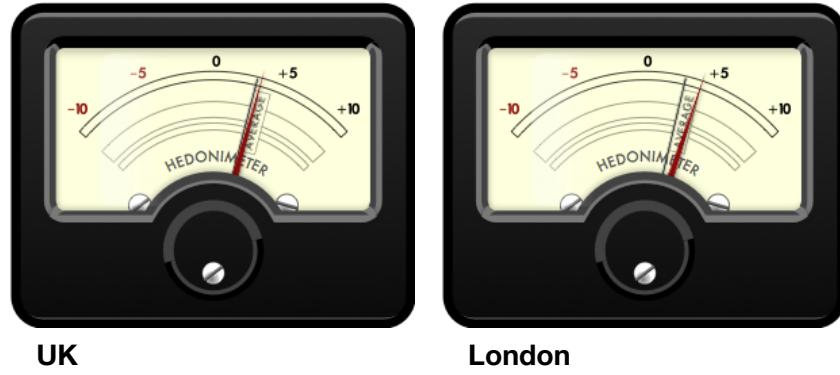


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when are we happy?

The **hedonimeters** on the right display mappiness users' happiness in real-time, compared against the all-time average.

Below, happiness levels are charted hour by hour over the past week.



Click and drag to zoom. Double-click to zoom back out.

hedoniwhat?

As imagined in 1881 by the economist [Edgeworth](#),

... let there be granted to the science of pleasure what is granted to the science of energy; to imagine an ideally perfect instrument, a psychophysical machine, continually registering the height of pleasure experienced by an individual, exactly according to the verdict of consciousness, or rather diverging therefrom according to a law of errors. From moment to moment the hedonimeter varies; the delicate index now flickering with the flutter of the passions, now steadied by intellectual activity, low sunk whole hours in the neighbourhood of zero, or momentarily springing up towards infinity. The continually indicated height is registered by photographic or other frictionless apparatus upon a uniformly moving vertical plane ...

(David Colander, 2007. Edgeworth's Hedonimeter and the Quest to Measure Utility. *Journal of Economic Perspectives* 21 p. 217. [JSTOR](#))

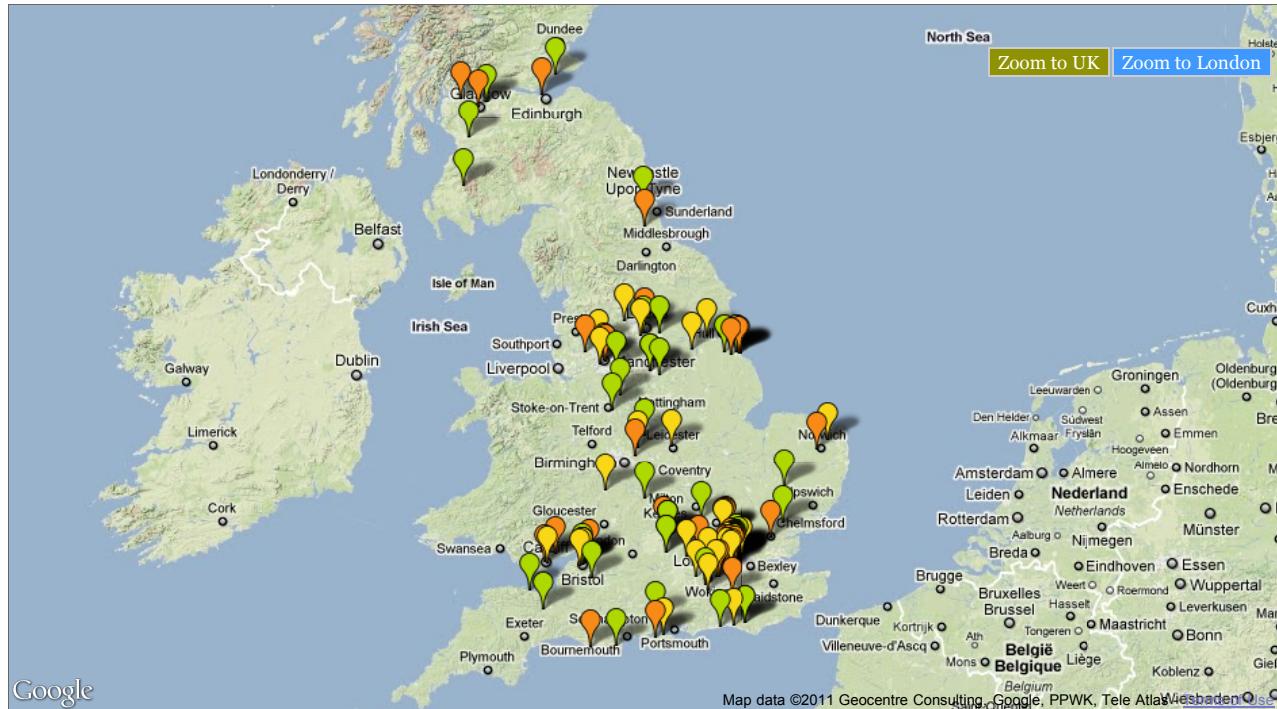
[Share + 41](#) [Tweet 0](#) [Digg](#) [reddit this!](#)

We have **41,260** participants. We'd love more. Please share!

[Open Feedback Dialog](#)



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where are we happy?

These are the places where mappiness users have most recently reported feeling happy.

[Share ↗ 74](#) [Tweet ↗ 0](#) [Digg ↗ 0](#) [reddit this!](#)

We have **41,260** participants. We'd love more. Please share!



[Home](#) [News](#) [Meters](#) [Maps](#) [More info](#)

who's behind this?

mappiness is created by [George MacKerron](#) and [Susana Mourato](#) of the [Department of Geography & Environment](#) and the [Grantham Research Institute on Climate Change and the Environment](#) at the [London School of Economics and Political Science](#) (LSE).

We want to better understand how people's feelings are affected by features of their current environment—things like air pollution, noise, and green spaces.



We'd love to hear from you.

- [Use our feedback forum](#) to share your thoughts
- Email: g.j.mackerron@lse.ac.uk or s.mourato@lse.ac.uk
- Or call: [+44 \(0\)20 7193 7369](tel:+44(0)2071937369)

tell me more about the app

what will I do?

First, you'll need to [download the free app to your iPhone](#).

You'll provide some basic demographic and health-related information, and confirm some settings in order to sign up.

After that, you'll receive a notification (beep) on your iPhone between one and five times a day, at your choice. This will come at a random moment during hours you agree.

The notification will prompt you to open the app, to briefly report how you're feeling and—in very broad terms—who you're with, where you are, and what you're doing. If you're outdoors and you're happy to, you'll take a photo of your surroundings too.

(You can also open the app and report on your feelings and situation, unprompted, as often as you like).

how long will it take?

The sign-up process should take no more than 5 minutes. The daily reports on your feelings and situation will take about 30 seconds each.

You can keep taking part in the study for as long (or short) a period as you want.

what data will I be sharing?

While you report your feelings and situation, the app will use your iPhone's GPS (sat-nav) to discover your approximate location. It will also use the microphone to measure ambient noise levels (but it *won't* record any sound).

When you finish responding, the app will send the answers, noise level measure, location data and photo (if you took one) to our secure data

store.

what will you do with this data?

We'll use it solely for our academic research.

We'll apply statistical methods to the combined responses from everyone taking part. We'll use the location data to estimate what the environment was like in the places where people responded. And we'll be looking at the effect of this on people's feelings, while controlling for some other potential influences.

If you're curious to see what we find, please come back to this site from time to time: we'll be posting results here. We also hope to present our findings in academic journals and at conferences, and to make sure policy-makers are aware of anything important.

In all cases, we'll never report any individual's responses—only information at the group level.

and the photos?

If you take a photo we may try to classify it, either manually or using a computer program, to add extra information about your immediate surroundings (for example, are there trees visible?).

If you explicitly agree—and we'll check this with you for every photo—we may also feature it on [the map](#).

is it anonymous?

Yes. We won't know who you are. We don't ask for your name or for any other identifying information, and we don't need your phone number to send notifications to your iPhone. In principle, given enough responses, it might be possible to identify you from your location data, but we promise we won't try.

is it confidential?

Yes. We won't disclose your data to any third party unless (1) we're required by law to do so, or (2) we do so under a strict contractual agreement with other academic researchers, exclusively for the purpose of academic research at a recognised institution.

is it secure?

Yes. All communication between the app and our data store is over an SSL-encrypted connection, the same kind used for online banking and shopping. The data store is a firewalled and fully updated Linux server.

is it easy to get out of?

Yes! Taking part is completely voluntary. You can withdraw at any time and without giving a reason: just delete the app from your iPhone. You could also ask us to delete all your data from our data store.

Alternatively you can take a break from the study by changing your notifications per day to zero on the Settings screen within the app.

how much data does it use?

Not much. Responding to a notification generally uses as much data as sending a brief email (around 1KB). If you're outdoors and take a picture, it's more like viewing a simple web page (15 – 20KB). Getting your status when you open the app uses less than 1KB. Viewing your graphed responses uses about 3KB.

So if you respond to two beeps per day, and you take a photo on 20% of

these occasions, you'll use about 350KB per month. (If you have an inclusive data bundle, this is probably less than 0.1% of it.)

You may want to turn off data when you're abroad (roaming), though, as this can be very expensive.

I'm not in the UK — can I take part?

You're welcome to, but we may not use your data in our research. And look out for the time difference when setting the hours when you can be beeped: all times in the app are UK times (GMT or GMT+1).

I have another question...

Great. Please get in touch: see our [contact details at the top of this page](#).

thanks

Many thanks are due to:

- all our app users and testers.
- our colleagues, for encouragement and good ideas.
- the [Economic & Social Research Council](#), for funding enabling this work.



This project sits on top of a huge stack of free and open-source software. So we'd also like to thank the authors of and contributors to:

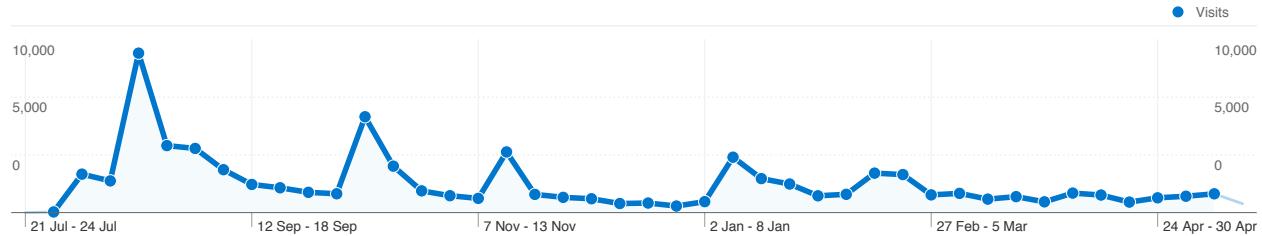
[pyapns](#), [Cocoa With Love](#), [Bluff](#), [json-framework](#), [Listener](#), [GeoRuby](#), [Spatial Adapter](#), [ActiveRecord](#), [Ojay](#), [YUI](#), [960 Grid System](#), [dygraphs](#), [FlashCanvas](#), [PostGIS](#), [PostgreSQL](#), [Sinatra](#), [Rack](#), [Ruby](#), [Phusion Passenger](#), [nginx](#), [Ubuntu](#).



We have **41,260** participants. We'd love more. Please share!

B.7 Website visit statistics

These statistics were produced by Google Analytics. Only the top 100 traffic sources are shown.



All traffic sources sent 72,219 visits via 1,421 sources and mediums + keywords

Site Usage						
Visits 72,219 % of Site Total: 100.00%	Pages/Visit 1.93 Site Avg: 1.93 (0.00%)	Avg. Time on Site 00:01:18 Site Avg: 00:01:18 (0.00%)	% New Visits 75.01% Site Avg: 74.97% (0.06%)	Bounce Rate 65.95% Site Avg: 65.95% (0.00%)		
Source/Medium	Keyword	Visits	Pages/Visit	Avg. Time on Site	% New Visits	Bounce Rate
(direct) / (none)	(not set)	23,979	1.77	00:01:10	74.69%	70.44%
google / organic	mappiness	15,522	2.54	00:01:58	55.53%	46.82%
facebook.com / referral	(not set)	3,274	1.41	00:00:41	93.43%	81.12%
news.ycombinator.com / referral	(not set)	2,411	1.41	00:00:31	95.19%	82.46%
twitter.com / referral	(not set)	2,324	1.41	00:00:38	87.69%	82.66%
bbc.co.uk / referral	(not set)	1,810	1.91	00:01:25	93.81%	67.57%
actionforhappiness.org / referral	(not set)	1,707	1.74	00:01:08	83.07%	74.81%
swiss-miss.com / referral	(not set)	1,134	1.93	00:01:22	83.42%	66.58%
slate.fr / referral	(not set)	1,007	1.48	00:00:23	97.62%	73.09%
google / organic	mappiness.org.uk	932	2.51	00:01:42	56.12%	48.39%
google.com / referral	(not set)	811	1.59	00:00:54	85.33%	74.97%
techcrunch.com / referral	(not set)	760	1.92	00:01:25	87.24%	63.03%
www2.lse.ac.uk / referral	(not set)	684	2.60	00:02:10	76.02%	52.63%
google / organic	mapiness	504	2.53	00:01:43	77.18%	44.84%
metafilter.com / referral	(not set)	468	1.31	00:00:40	88.03%	82.69%
telegraph.co.uk / referral	(not set)	464	2.33	00:01:58	77.37%	54.96%
delicious.com / referral	(not set)	424	1.47	00:00:36	73.35%	81.60%
movementforhappiness.org / referral	(not set)	407	1.89	00:01:18	82.31%	71.99%
stumbleupon.com / referral	(not set)	350	1.06	00:00:10	98.57%	93.71%
guardian.co.uk / referral	(not set)	339	1.73	00:01:05	80.53%	71.68%
good.is / referral	(not set)	320	1.59	00:01:03	77.50%	72.19%
catless.ncl.ac.uk / referral	(not set)	299	1.05	00:00:04	95.32%	97.32%
iconfactory.com / referral	(not set)	294	1.14	00:00:14	95.24%	91.84%

googlemapsmania.blogspot.com / referral	(not set)	223	2.22	00:01:04	95.07%	48.43%
technaute.cyberpresse.ca / referral	(not set)	217	1.41	00:00:29	94.01%	81.57%
mac-essentials.de / referral	(not set)	213	1.39	00:00:27	82.63%	80.28%
sopitas.com / referral	(not set)	210	1.11	00:00:18	98.57%	91.90%
mackreron.com / referral	(not set)	207	2.50	00:02:10	66.18%	50.72%
news.bbc.co.uk / referral	(not set)	206	1.52	00:00:25	96.60%	77.67%
cienciahoje.pt / referral	(not set)	204	1.50	00:00:28	35.29%	81.37%
lavanguardia.es / referral	(not set)	200	1.49	00:00:45	97.50%	80.50%
bobulate.com / referral	(not set)	195	2.10	00:01:58	89.74%	58.97%
telematin.france2.fr / referral	(not set)	188	1.32	00:00:35	88.83%	84.04%
lemondrop.com / referral	(not set)	184	1.20	00:00:37	96.74%	88.04%
fastcompany.com / referral	(not set)	168	1.98	00:01:32	76.19%	59.52%
elle.cz / referral	(not set)	145	1.19	00:00:15	97.24%	89.66%
quantifiedself.com / referral	(not set)	145	1.41	00:00:54	92.41%	84.83%
g1.globo.com / referral	(not set)	140	1.15	00:00:05	97.86%	91.43%
20kaido.com / referral	(not set)	139	1.35	00:00:39	92.09%	86.33%
healthzone.ca / referral	(not set)	135	1.75	00:00:48	98.52%	63.70%
google / organic	mappiness app	133	2.11	00:01:34	81.20%	58.65%
thestar.com / referral	(not set)	131	1.62	00:00:56	83.97%	77.10%
news.com.au / referral	(not set)	130	1.78	00:00:58	89.23%	72.31%
m.facebook.com / referral	(not set)	129	1.08	00:00:07	95.35%	95.35%
nrk.no / referral	(not set)	125	2.45	00:01:25	73.60%	51.20%
google / organic	Ise mappiness	124	3.15	00:02:34	59.68%	39.52%
metro.co.uk / referral	(not set)	120	2.38	00:01:59	69.17%	52.50%
personal.lse.ac.uk / referral	(not set)	117	2.80	00:03:36	70.94%	38.46%
blog.mappiness.org.uk / referral	(not set)	108	2.19	00:01:55	31.48%	53.70%
google / organic	mappyness	108	2.51	00:01:34	75.00%	49.07%
neweconomics.org / referral	(not set)	107	3.39	00:03:47	85.05%	31.78%
planetgreen.discovery.com / referral	(not set)	106	1.95	00:01:44	90.57%	64.15%
google.co.uk / referral	(not set)	103	2.08	00:01:56	83.50%	58.25%
diigo.com / referral	(not set)	94	1.28	00:00:37	5.32%	93.62%
bing / organic	mappiness	92	3.12	00:03:09	68.48%	31.52%
ask.metafilter.com / referral	(not set)	91	1.15	00:00:06	95.60%	90.11%
yahoo / organic	mappiness	84	2.55	00:01:44	75.00%	39.29%

reddit.com / referral	(not set)	82	1.52	00:00:41	98.78%	70.73%
google / organic	www.mappiness.org.uk	80	2.49	00:01:32	82.50%	50.00%
hootsuite.com / referral	(not set)	80	1.49	00:00:44	87.50%	77.50%
google / organic	mappiness project	78	1.68	00:00:43	32.05%	76.92%
google / organic	http://www.mappiness.org.uk/	77	3.19	00:03:24	59.74%	37.66%
veja.abril.com.br / referral	(not set)	73	1.38	00:00:56	69.86%	78.08%
fr-ca.actualites.yahoo.com / referral	(not set)	71	1.14	00:00:06	97.18%	92.96%
bing / organic	+mappiness	69	2.74	00:02:08	65.22%	40.58%
projects.rsablogs.org.uk / referral	(not set)	69	1.86	00:00:53	63.77%	71.01%
jp.techcrunch.com / referral	(not set)	67	2.03	00:00:56	88.06%	53.73%
google / organic	mappiness.org	65	2.72	00:02:20	63.08%	36.92%
sd.defra.gov.uk / referral	(not set)	65	2.88	00:01:31	90.77%	33.85%
derstandard.at / referral	(not set)	64	2.38	00:01:00	87.50%	53.12%
okansas.blogspot.com / referral	(not set)	63	1.41	00:00:31	71.43%	85.71%
google / organic	mappiness lse	61	2.79	00:02:31	52.46%	55.74%
knack.rnews.be / referral	(not set)	61	1.18	00:00:03	98.36%	93.44%
swissmiss / email	(not set)	60	1.38	00:00:22	96.67%	78.33%
uk.mc250.mail.yahoo.com / referral	(not set)	59	1.07	00:00:28	1.69%	93.22%
bing / organic	mappiness map	56	2.07	00:02:39	0.00%	14.29%
itunes.apple.com / referral	(not set)	56	2.18	00:01:22	73.21%	60.71%
search / organic	mappiness	56	2.77	00:06:32	32.14%	44.64%
google / organic	mappiness iphone app	51	1.73	00:01:51	49.02%	76.47%
google / organic	mappingness lse	49	1.04	00:00:11	2.04%	97.96%
madebymany.com / referral	(not set)	49	1.92	00:00:49	95.92%	69.39%
tonic.com / referral	(not set)	47	1.40	00:00:48	57.45%	78.72%
grynas.lt / referral	(not set)	46	1.28	00:00:27	100.00%	91.30%
linkedin.com / referral	(not set)	46	2.07	00:00:40	100.00%	76.09%
mobile.twitter.com / referral	(not set)	46	1.13	00:00:19	93.48%	89.13%
tg24.sky.it / referral	(not set)	45	1.22	00:01:14	6.67%	88.89%
fem.com / referral	(not set)	44	1.27	00:00:13	95.45%	86.36%
moodscope.com / referral	(not set)	44	1.84	00:01:12	97.73%	63.64%
psfk.com / referral	(not set)	43	2.86	00:03:09	90.70%	53.49%
mrweb.com / referral	(not set)	42	2.17	00:01:34	85.71%	61.90%
news.cnet.com / referral	(not set)	42	1.71	00:00:48	95.24%	71.43%

blog.mackerron.com / referral	(not set)	41	2.76	00:05:41	17.07%	34.15%
nhswebtools.com / referral	(not set)	41	1.44	00:00:23	73.17%	82.93%
largeur.com / referral	(not set)	40	1.55	00:00:51	100.00%	75.00%
google / organic	mappiness iphone	39	2.13	00:01:25	89.74%	51.28%
google / organic	mapping happiness	38	3.05	00:07:12	52.63%	44.74%
google / organic	http://mappiness.org.uk/	37	3.16	00:03:14	83.78%	37.84%
oeilbylaser.com / referral	(not set)	36	1.56	00:01:45	52.78%	80.56%
blogs.lse.ac.uk / referral	(not set)	35	3.66	00:02:18	80.00%	28.57%
google / organic	mappinness	35	2.91	00:01:45	62.86%	37.14%

1 - 100 of 1,421

B.8 Consent form in app

Please read this information carefully. By tapping "I agree" below, you confirm that:

- The nature and purpose of this research have been explained to your satisfaction.
- You agree to take part in the study.
- You understand that you can withdraw at any time.
- You're at least 18 years old, and this is your iPhone.

Please scroll down to see the rest of the information. You can refer back it at any time in the 'Info & help' section of the app.

What's this research for? We want to better understand how people's feelings are affected by features of their current environment—things like air pollution, noise, and green spaces.

What will I do? You'll provide some basic demographic and health-related information, and confirm some settings in order to sign up.

After that, you'll receive a notification (beep) on this iPhone between one and five times a day, at your choice. This will come at a random moment during hours you agree.

The notification will prompt you to open this app, to briefly report how you're feeling and—in very broad terms—who you're with, where you are, and what you're doing. If you're outdoors and you're happy to, you'll take a photo of your surroundings too.

(You can also open this app and report on your feelings and situation, unprompted, as often as you like).

How long will it take? The sign-up process should take no more than 5 minutes. The daily reports on your feelings and situation will take about 30 seconds each.

You can keep taking part in the study for as long (or short) a period as you want.

What data will I be sharing? While you report your feelings and situation, the app will use your iPhone's GPS (sat-nav) to discover your approximate location. It will also use the microphone to measure ambient noise levels (but it *won't* record any sound).

When you finish responding, the app will send the answers, noise level measure, location data and photo (if you took one) to our secure data store.

What will you do with this data? We'll use it solely for our academic research.

We'll apply statistical methods to the combined responses from everyone taking part. We'll use the location data to estimate what the environment was like in the places where people responded. And we'll be looking at the effect of this on people's feelings, while controlling for some other potential influences.

If you're curious to see what we find, please visit mappiness.org.uk from time to time: we'll be posting results there. We also hope to present our findings in academic journals and at conferences, and to make sure policy-makers are aware of anything important.

In all cases, we'll never report any individual's responses—only information at the group level.

And the photos? If you take a photo we may try to classify it, either manually or using a computer program, to add extra information about your immediate surroundings (for example, are there trees visible?).

If you explicitly agree—and we'll check this with you for every photo—we may also feature it on a public map at mappiness.org.uk.

Is it anonymous? Yes. We won't know who you are. We don't ask for your name or for any other identifying information, and we don't need your phone number to send notifications to your iPhone. In principle, given enough responses, it might be possible to identify you from your location data, but we promise we won't try.

Is it confidential? Yes. We won't disclose your data to any third party unless (1) we're required by law to do so, or (2) we do so under a strict contractual agreement with other academic researchers, exclusively for the purpose of academic research at a recognised institution.

Is it secure? Yes. All communication between this app and our data store is over an SSL-encrypted connection, the same kind used for online banking and shopping. The data store is a firewalled and fully updated Linux server, accessible only over a secure connection.

Is it easy to get out of? Yes! Taking part is completely voluntary. You can withdraw at any time and without giving a reason: just delete this app from your iPhone. You could also ask us to delete all your data from our data store.

Alternatively you can take a break from the study by changing your notifications per day to zero on the Settings screen within the app.

How much data does it use? Not much. Responding to a notification generally uses as much data as sending a brief email (around 1KB). If you're outdoors and take a picture, it's more like viewing a simple web page (a little over 10KB). Getting your status when you open the app uses less than 1KB. Viewing your graphed responses uses about 3KB.

So if you respond to one beep per day, and you take a photo on 25% of these occasions, you'll use about 150KB per month. (If you have an inclusive data bundle, this is probably less than 0.1% of it.)

You may want to turn off data when you're abroad (roaming), though, as this can be very expensive.

I'm not in the UK. Can I take part? You're welcome to, but we may not use your data in our research. And look out for the time difference when setting the hours when you can be beeped: all times in the app are UK times (GMT or GMT+1).

I have another question... If there's anything else you'd like to know, please contact George MacKerron or Dr Susana Mourato:

- Email George at g.j.mackerron@lse.ac.uk. You can do this right now: just tap the button at the top right of this screen.
- Call us on 020 7193 7369.
- Or write to us at the Dept. of Geography & Environment, London School of Economics, Houghton Street, London WC2A 2AE.

Thank you!

B.9 FAQs in app

What's the *How do you feel?* button for? Tap this button to volunteer information about your happiness (and the other things we ask) at any time, whether or not you have a beep outstanding.

We may not use this volunteered information as part of our research, since it's unlikely to represent a random sample of experiences. However, you will see this information reflected in the data in the *My happiness* section.

What are the stats on the main screen for? These three stats describe the quality of your response data.

For our research to be valid, we need a random sample of experiences. The sample is best randomised when you respond as soon as possible to every beep. This is because times when you don't respond, or only respond later, could be systematically different from times when you do respond, and respond straight away.

- *Number of responses* is the total tally of responses you've given—both when you were beeped, and when you volunteered the information by tapping the *How do you feel?* button.
- *Response rate* is the percentage of the times we beeped you that you gave a response. We'd love it if you managed a rate of 100%, but anything over 75% is great. The first response following a beep counts as the response to that beep. (If we've sent two or more beeps without a response, it's then only possible to respond to the most recent one.)
- *Typical response time* is the time it generally takes for you to respond to a beep. 1 – 2 minutes would be excellent here. (What we show here is the *median* time: we line up your response times in order, from shortest to longest, and pick the middle one.)

My stats are wrong! Why? Beeps are not delivered 100% reliably, so it's possible that an undelivered beep could unfairly reduce your response rate. If that happens to you, we apologise!

Similarly, beeps are not always delivered immediately, and a beep that's delayed could increase your median response time. Again, sorry.

If you think there's something else wrong with your stats, please get in touch.

What if someone calls while I'm responding to a beep? The answers you've given up to that point will be saved, and will be sent when the app reopens.

What if I quit the app while it's sending data? This isn't a problem. The data will be sent next time you open the app.

What if I'm abroad (roaming)? Please note:

- We're unlikely to use data from outside the UK in our research.
- If you've turned off data roaming (and you may want to, since it's rather expensive) you'll only get beeped when connected to a WiFi network.
- You can still volunteer information by tapping the *How do you feel?* button. Your responses will be queued for sending the next time you open the app in WiFi range or back home.
- The times used by the app are always UK times, no matter where you are. So you'll probably need to change the hours when you can be beeped in the in-app Settings.

I was beeped after my *Don't beep after* time. What's going on? We're sorry about this. Sending a beep is similar to sending a text message. If your phone isn't available when we beep you (e.g. it's off, or has no signal) the beep gets queued until your phone is available again.

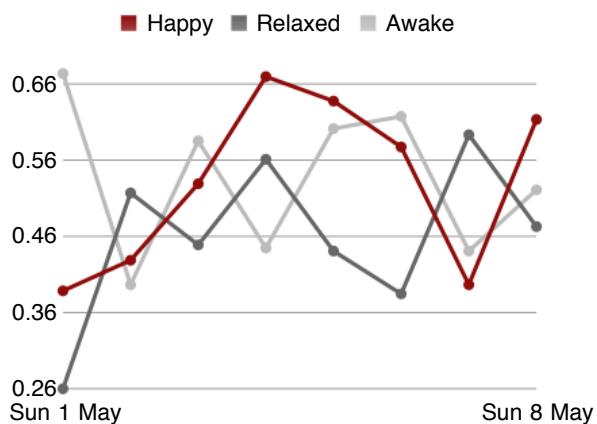
Sometimes a beep won't be delivered immediately even if your phone *is* available. To help deal with this, we stop sending beeps ten minutes before your *Don't beep after* time. But this isn't always enough, so if it's really important that you're not disturbed by a rogue after-hours beep, we recommend you set your iPhone to silent during these periods.

B.10 Participant feedback charts sample

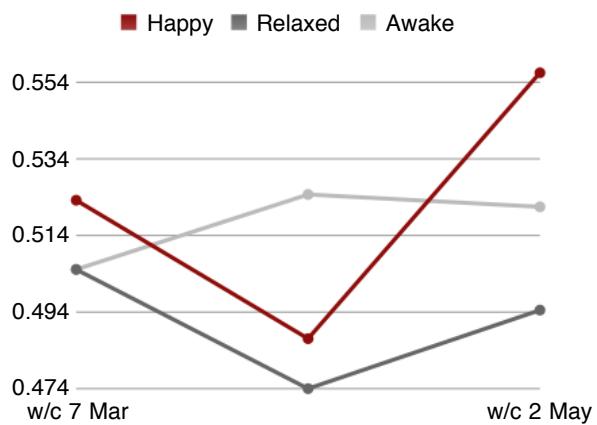
my happiness

How has my happiness varied over time?

This chart plots all reported feelings over **7 days up to your latest response.**

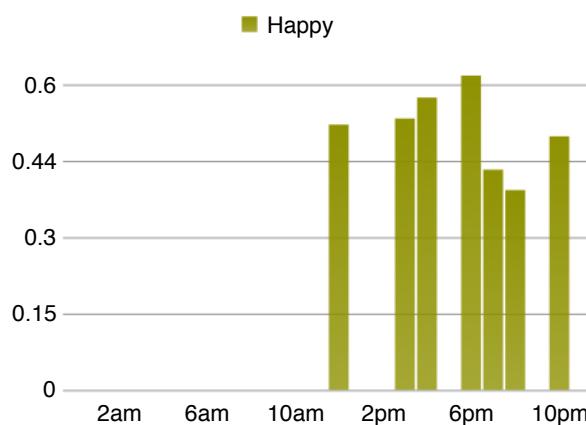
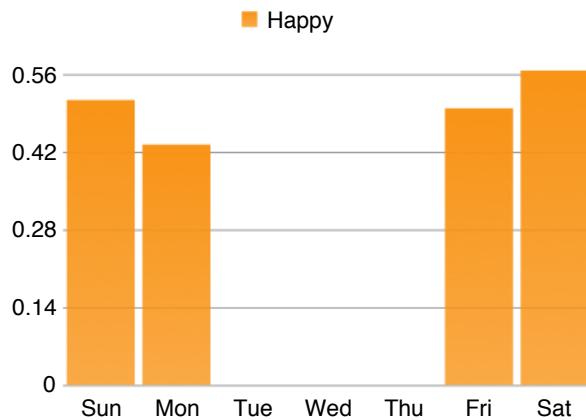


And these are your **weekly averages**, Mon – Sun (omitting 6 weeks with no responses).



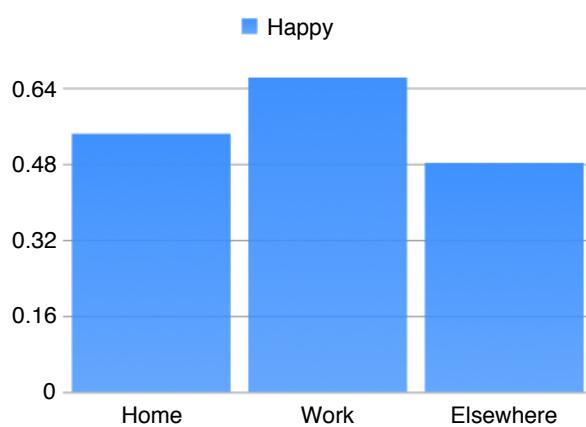
When am I happiest?

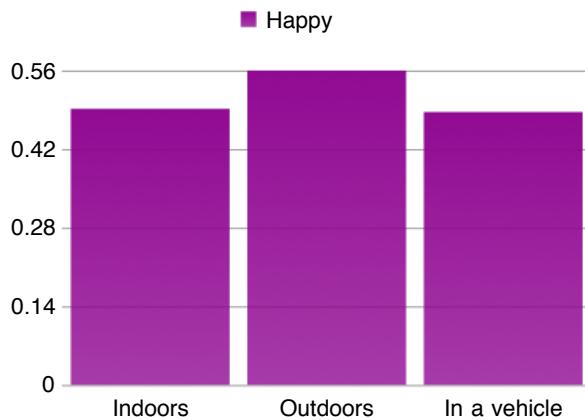
These charts show your average happiness by day of the week and hour of the day.



Where am I happiest?

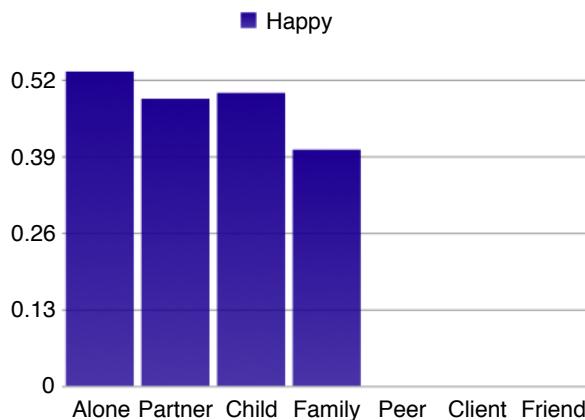
These charts compare your average happiness in different locations.





With whom am I happiest?

This chart compares your average happiness in the company of different people.



What am I happiest doing?

- #1. Singing, performing ×1 :)
- #2. Admin, finances, organising ×4
- #3. Shopping, errands ×1
- #4. Working, studying ×5
- #5. Housework, chores, DIY ×2
- #6. Cooking, preparing food ×4
- #7. Travelling, commuting ×1
- #8. In a meeting, seminar, class ×2
- #9. Gambling, betting ×1
- #10. Washing, dressing, grooming ×1
- #11. Sleeping, resting, relaxing ×1
- #12. Pet care, playing with pets ×1
- #13. Theatre, dance, concert ×1
- #14. Care or help for adults ×1
- #15. Meditating, religious activities ×1
- #16. Reading ×1
- #17. Intimacy, making love ×1 :(

The list is sorted by average happiness reported doing each activity. The numbers in grey (e.g. ×4) show how many reports each average is based on.

Don't take these data too seriously!

- Unless you've answered dozens of times, any apparent differences could just be random variation.
- Nothing is controlled for. So, for example, if you're usually at work when you're with your colleagues, the combined effect of both things will be seen in the data about both of them.

B.11 User interface mock-ups

User interface mock-ups are shown in [Figure B.1](#).

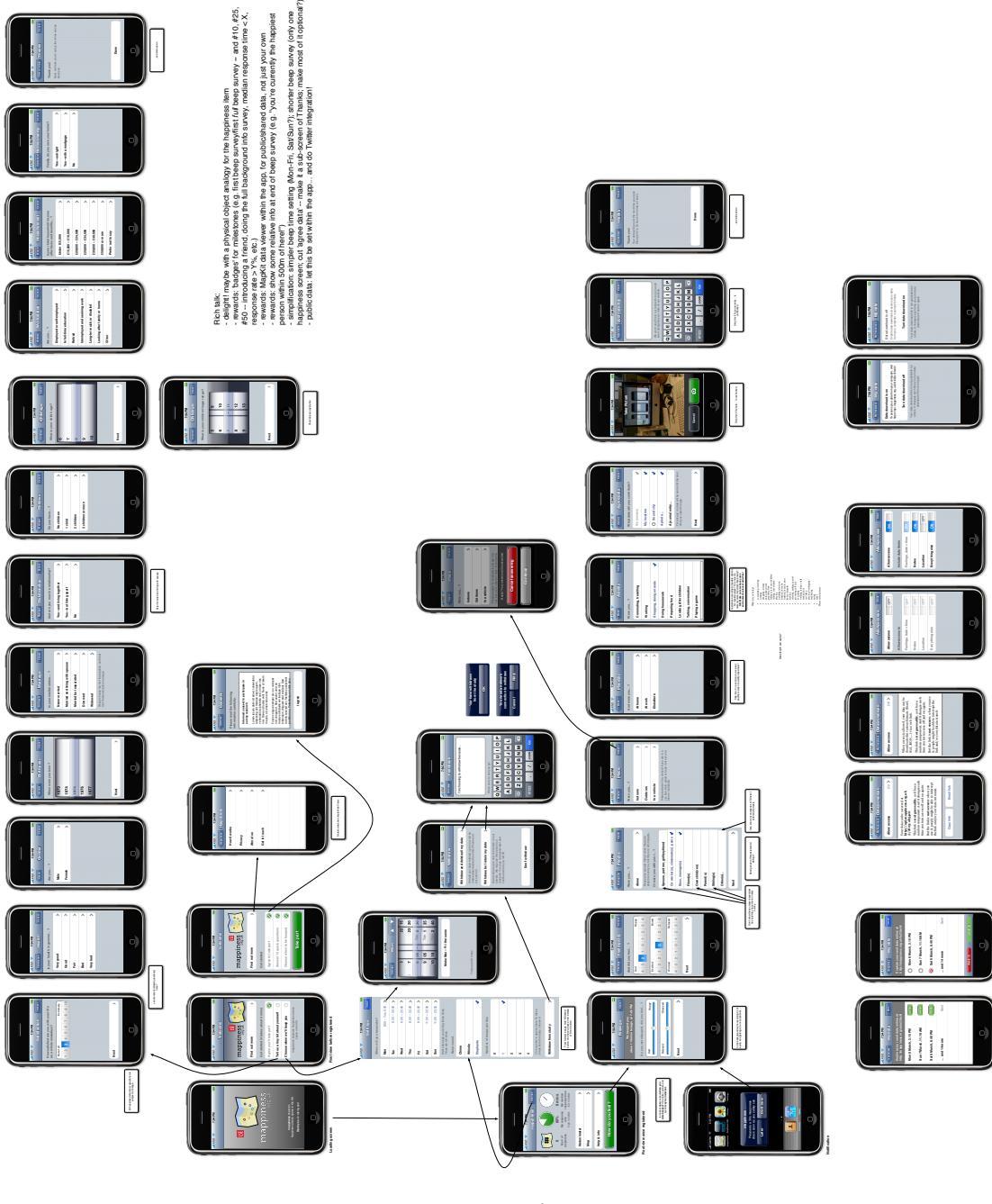


Figure B.1: User interface mock-ups (created with Interface Builder and OmniGraffle Pro)

Appendix C

Supplementary information for analytical methods

C.1 Daylight calculations

```
1 -- in R: install.packages('StreamMetabolism', dependencies = TRUE)
2
3 create or replace function _r_daylight_period(lat double precision, lon double precision, datestring text, timezone
4   text default 'UTC')
5   returns setof double precision as $$
6     library('StreamMetabolism')
7     df <- sunrise.set(lat, lon, datestring, timezone)
8     ss <- c(df$sunrise, df$sunset)
9     return(ss)
10    $$ language plr immutable strict;
11
12 create or replace function is_daylight(location geometry, moment timestamp without time zone, timezone text)
13   returns boolean as $$
14   select
15     $2 at time zone $3
16     > timestamp with time zone '1970-01-01 00:00:00-00' + cast(min(dp) || 'seconds' as interval)
17     and $2 at time zone $3
18     < timestamp with time zone '1970-01-01 00:00:00-00' + cast(max(dp) || 'seconds' as interval)
19   from
20     _r_daylight_period(
21       st_y(st_transform($1, 4326)), -- 4326 -> WGS84 projection, as required
22       st_x(st_transform($1, 4326)),
23       to_char($2, 'YYYY/MM/DD'),
24       $3
25     ) dp;
26   $$ language sql immutable strict;
27
28 create table esm_daylight as ( -- assumes UK time zone, so valid for UK responses only
29   select
30     id as esm_id,
31     case when is_daylight(location, _start, 'Europe/London') then 1 else 0 end as is_daylight
32   from esm_answer_sets
33 );
34
```

C.2 House price regressions

The fixed effects and OLS regression model estimates are given in Table C.1 and Table C.2 respectively.

C.3 Kernel-weighted proportion approximation functions

```
1 -- kernel functions
2
3 create or replace function uniform_pdf
4 ( double precision      -- $1 = x
5 , double precision default 1.0 -- $2 = bandwidth
6 , double precision default 0.0 -- $3 = centre
7 ) returns double precision as $$
8   select
9   case
10    when $1 > $3 - $2 and $1 < $3 + $2 then (
```

Table C.1: House price LSOA fixed effects regression model

Variable	Coeff.	Std. dev.	Variable	Coeff.	Std. dev.
Floor area, ln(m ²)	0.48***	(0.0019)			
<i>Bedrooms (base: 1)</i>			<i>Property type (base: detached house)</i>		
2	0.10***	(0.0015)	Semi-detached house	-0.16***	(0.0010)
3	0.14***	(0.0018)	Terraced house	-0.24***	(0.0013)
4	0.20***	(0.0022)	Country cottage	-0.033	(0.032)
5	0.26***	(0.0032)	Detached bungalow	0.078***	(0.0016)
6	0.27***	(0.0074)	Semi-detached bungalow	-0.044***	(0.0021)
<i>Bathrooms (base: 1)</i>			Purpose-built flat	-0.29***	(0.0026)
2	0.052***	(0.00099)	Purpose-built maisonette	-0.38***	(0.0055)
3	0.097***	(0.0027)	Flat conversion	-0.26***	(0.0032)
4	0.14***	(0.039)	Maisonette conversion	-0.29***	(0.0038)
<i>Parking (base: single garage)</i>			New-build property	0.11***	(0.0019)
Double garage	0.096***	(0.0013)			
Parking space	-0.027***	(0.00075)	<i>Date built (base: 1400 – 1799)</i>		
None	-0.10***	(0.00091)	1800 – 1849	-0.082***	(0.0041)
<i>Central heating (base: none)</i>			1850 – 1899	-0.18***	(0.0036)
Full, gas	0.087***	(0.0010)	1900 – 1924	-0.23***	(0.0035)
Full, electric	0.081***	(0.0018)	1925 – 1949	-0.22***	(0.0035)
Full, oil	0.15***	(0.0025)	1950 – 1974	-0.26***	(0.0035)
Full, solid fuel	0.060***	(0.0035)	1975 – 1999	-0.19***	(0.0035)
Part, gas	0.033***	(0.0016)	2000 onwards	-0.19***	(0.0041)
Part, electric	0.043***	(0.0017)			
Part, oil	0.081***	(0.0073)	<i>36 sale quarter dummies</i>	Yes	
Part, solid fuel	0.017**	(0.0060)			
<i>Tenure (base: freehold)</i>			<i>Constant</i>	8.94***	(0.010)
Leasehold	-0.059***	(0.0021)			
Feuhold	-0.042***	(0.0077)	<i>Observations</i>	788185	
			<i>Groups (LSOAs/Data Zones)</i>	40206	
			<i>R² (within groups)</i>	83.3%	

Dependent variable: logged sale price.

Standard errors are clustered at LSOA/Data Zone level.

Includes only properties having $7 > \text{bedrooms} > 0$ and $\text{bathrooms} > 0$.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.2: House price OLS regression model

Variable	Coeff.	Std. dev.	Variable	Coeff.	Std. dev.
Floor area, ln(m ²)	0.55***	(0.0031)			
<i>Bedrooms (base: 1)</i>			<i>Property type (base: detached house)</i>		
2	0.0025	(0.0027)	Semi-detached house	-0.13***	(0.0017)
3	0.0096**	(0.0032)	Terraced house	-0.16***	(0.0020)
4	0.092***	(0.0039)	Country cottage	-0.080*	(0.041)
5	0.18***	(0.0057)	Detached bungalow	0.054***	(0.0027)
6	0.14***	(0.014)	Semi-detached bungalow	-0.065***	(0.0034)
<i>Bathrooms (base: 1)</i>			Purpose-built flat	0.13***	(0.0035)
2	0.13***	(0.0018)	Purpose-built maisonette	0.046***	(0.0082)
3	0.24***	(0.0049)	Flat conversion	0.26***	(0.0047)
4	0.40***	(0.068)	Maisonette conversion	0.11***	(0.0062)
<i>Parking (base: single garage)</i>			New-build property	0.043***	(0.0030)
Double garage	0.11***	(0.0021)			
Parking space	-0.054***	(0.0014)	<i>Date built (base: 1400 – 1799)</i>		
None	-0.11***	(0.0016)	1800 – 1849	-0.13***	(0.0066)
<i>Central heating (base: none)</i>			1850 – 1899	-0.18***	(0.0056)
Full, gas	0.22***	(0.0019)	1900 – 1924	-0.33***	(0.0054)
Full, electric	0.16***	(0.0031)	1925 – 1949	-0.22***	(0.0053)
Full, oil	0.064***	(0.0044)	1950 – 1974	-0.32***	(0.0052)
Full, solid fuel	-0.064***	(0.0049)	1975 – 1999	-0.30***	(0.0052)
Part, gas	0.092***	(0.0032)	2000 onwards	-0.40***	(0.0060)
Part, electric	0.069***	(0.0032)			
Part, oil	0.094***	(0.011)	<i>36 sale quarter dummies</i>	Yes	
Part, solid fuel	-0.049***	(0.0094)			
<i>Tenure (base: freehold)</i>			Constant	8.64***	(0.016)
Leasehold	-0.094***	(0.0022)			
Feuhold	-0.34***	(0.0024)	Observations	822051	
			R-squared	56.2%	

Dependent variable: logged sale price.

Standard errors are sandwich estimators clustered at full postcode level.

Includes only properties having 7 > bedrooms > 0 and bathrooms > 0.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

```

11      select cast(0.5 as double precision)
12    )
13  else 0
14 end;
15 $$ language sql immutable;
16
17 create or replace function triangular_pdf
18 ( double precision      -- $1 = x
19 , double precision default 1.0 -- $2 = bandwidth
20 , double precision default 0.0 -- $3 = centre
21 ) returns double precision as $$*
22 select
23 case
24   when $1 > $3 - $2 and $1 < $3 + $2 then (
25     select 1 - abs(($1 - $3) / $2)
26   )
27   else 0
28 end;
29 $$ language sql immutable;
30
31 create or replace function normal_pdf
32 ( double precision      -- $1 = x
33 , double precision default 1.0 -- $2 = std dev (bandwidth)
34 , double precision default 0.0 -- $3 = mean (centre)
35 ) returns double precision as $$*
36 select (1.0 / (sqrt(2.0 * pi() * pow($2, 2))))
37   * exp(-pow($1 - $3, 2) / (2.0 * pow($2, 2)));
38 $$ language sql immutable;
39
40 create or replace function epanechnikov_pdf
41 ( double precision      -- $1 = x
42 , double precision default 1.0 -- $2 = bandwidth
43 , double precision default 0.0 -- $3 = centre
44 ) returns double precision as $$*
45 select
46 case
47   when $1 > $3 - $2 and $1 < $3 + $2 then (
48     select 0.75 * (1 - pow((($1 - $3) / $2, 2))
49   )
50   else 0
51 end;
52 $$ language sql immutable;
53
54
55 -- current kernel function
56 -- (uncomment the kernel you want to use, and redefine: the normal is shown here)
57
58 create or replace function __current_kernel_pdf
59 ( double precision      -- $1 = x
60 , double precision default 1.0 -- $2 = std dev/bandwidth
61 , double precision default 0.0 -- $3 = mean/centre
62 ) returns double precision as $$*
63 select
64   normal_pdf
65   -- epanechnikov_pdf
66   -- triangular_pdf
67   -- uniform_pdf
68   ($1, $2, $3);
69 $$ language sql immutable;
70
71
72 -- support functions
73
74 create or replace function __slice_height
75 ( double precision      -- $1 = kernel std dev
76 , double precision      -- $2 = kernel radius at top of slice
77 , double precision      -- $3 = kernel radius at bottom of slice
78 ) returns double precision as $$*
79 select __current_kernel_pdf($2, $1) - __current_kernel_pdf($3, $1);
80 $$ language sql immutable;
81
82 create or replace function __slice_radius
83 ( double precision      -- $1 = kernel radius at top of slice
84 , double precision      -- $2 = kernel radius at bottom of slice
85 ) returns double precision as $$*
86 select $1 + ((($2 - $1) / 2));
87 $$ language sql immutable;
88
89 create or replace function __kernel_slice_volume
90 ( double precision      -- $1 = kernel std dev
91 , double precision      -- $2 = kernel radius at top of slice
92 , double precision      -- $3 = kernel radius at bottom of slice
93 , int                  -- $4 = buffer precision
94 ) returns double precision as $$*
95 select
96   coalesce(
97     st_area(
98       st_buffer(
99         st_makeweight(0, 0),
100        __slice_radius($2, $3),
101        $4

```

```

102      )
103      ),
104      0
105      )
106      * __slice_height($1, $2, $3);
107 $$ language sql immutable;
108
109 create or replace function __intersected_slice_volume
110 ( geometry      -- $1 = area geometry
111 , geometry      -- $2 = kernel centre point geometry
112 , double precision -- $3 = kernel std dev
113 , double precision -- $4 = kernel radius at top of slice
114 , double precision -- $5 = kernel radius at bottom of slice
115 , int           -- $6 = buffer precision
116 ) returns double precision as $$  

117   select  

118     coalesce(  

119       st_area(  

120         st_intersection(  

121           $1,  

122           st_buffer(  

123             $2,  

124             __slice_radius($4, $5),  

125             $6  

126           ))  

127         ),  

128         0  

129       )  

130     * __slice_height($3, $4, $5);
131 $$ language sql immutable;
132
133
134
135 -- main function
136
137 create or replace function kernel_weighted_local_proportion
138 ( geometry      -- $1 = area geometry
139 , geometry      -- $2 = kernel centre point geometry
140 , double precision -- $3 = kernel std dev
141 , double precision -- $4 = truncation bandwidth (for normal only -- for others, repeat $3)
142 , int           -- $5 = number of slices for approximation
143 , int           -- $6 = buffer precision (points per 1/4 circle)
144 ) returns double precision as $$  

145   select  

146     sum(__intersected_slice_volume(  

147       $1, $2, $3,  

148       $4 * (cast(s as double precision) / $5),    -- kernel radius at top of slice  

149       $4 * (cast(s + 1 as double precision) / $5), -- kernel radius at bottom of slice  

150       $6  

151     ))  

152   /
153   sum(__kernel_slice_volume(  

154     $3,  

155     $4 * (cast(s as double precision) / $5),    -- kernel radius at top of slice  

156     $4 * (cast(s + 1 as double precision) / $5), -- kernel radius at bottom of slice  

157     $6  

158   ))  

159   from generate_series(0, $5 - 1) s;  

160 $$ language sql immutable;

```


Appendix D

Supplementary information for survey results

D.1 Demographic characteristics of web survey samples

Tables D.1, D.2, D.3 and D.4 provide summaries of demographic information for the UK and London surveys.

Figures D.1 and D.2 plot the household income distributions in the two surveys.

D.2 Aggregate subjective wellbeing scale calculations

D.2.1 SF-36

The SF-36 emotional wellbeing scale runs from 0 – 100 and is calculated as the mean of recoded responses to the following five questions RAND Health (nd).

How much of the time during the past 4 weeks...

24. Have you been a very nervous person?
25. Have you felt so down in the dumps that nothing could cheer you up?
26. Have you felt calm and peaceful?
28. Have you felt downhearted and blue?
30. Have you been a happy person?

Questions 26 and 30 — being positively phrased — are coded as follows:

- All of the time = 100
Most of the time = 80
A good bit of the time = 60
Some of the time = 40
A little of the time = 20
None of the time = 0

Questions 24, 25 and 28 — being negatively phrased — are coded in reverse:

- All of the time = 0
Most of the time = 20
A good bit of the time = 40
Some of the time = 60
A little of the time = 80
None of the time = 100

Table D.1: Demographic characteristics, UK web survey

	# of respondents	% of respondents	% in UK population†
<i>Gender</i>			
Female	959	51.0	51.6
Male	920	49.0	48.4
<i>Age</i>			
16 – 24	199	10.6	14.6
25 – 44	660	35.1	35.3
45 – 64	747	39.8	30.3
65+	270	14.5	19.8
<i>Marital status (Toluna data)</i>			
Never married	299	15.9	33.2
Married	771	41.1	51.7
Separated, divorced or widowed	185	9.9	16.7
(No data)	623	33.2	–
<i>Number of adults (age ≥ 16) in the household</i>			
1	416	22.2	
2	982	52.3	
3	298	15.9	
4 or more	182	9.7	
<i>Number of children (age < 16) in the household</i>			
0	1,437	76.5	
1	228	12.1	
2	143	7.6	
3	47	2.5	
4 or more	23	1.2	

† Comparator data for those aged 16+ from [Office for National Statistics \(2007a\)](#) except marital status from [Office for National Statistics \(2003a\)](#).

Table D.2: Education and employment, UK web survey

	# of respondents	% of respondents	% of respondents of working age	% in UK population of working age†
<i>Work status</i>				
In paid employment (full- or part-time)	802	42.7	50.7	65.1
Self employed	167	8.9	8.8	9.2
In full-time education	107	5.7		
Unemployed and seeking work	111	5.9	7.0	5.5
Looking after family or home	118	6.3		
Long-term sick or disabled	134	7.1		
Retired from paid work altogether	390	20.8		
On a government training scheme	2	0.1		
Caring for a sick, elderly or disabled person	12	0.6		
On maternity leave	6	0.3		
Other	29	1.5		
<i>Qualifications (Toluna data)</i>				
None	99	5.3	4.3	13.6
Below degree level	1019	54.3	55.3	67.8
Degree level and above	654	34.8	34.7	18.6
(No data)	106	5.6	5.7	—

† Comparator data from Office for National Statistics (2007a) applies to men aged 16 – 64 and women aged 16 – 59.

Table D.3: Demographic characteristics, London web survey

	# of respondents	% of respondents	% in London population†
<i>Gender</i>			
Female	459	54.4	50.9
Male	385	45.6	49.1
<i>Age</i>			
16 – 24	135	16.0	15.2
25 – 44	339	40.2	45.4
45 – 64	287	34.0	24.8
65+	83	9.8	14.6
<i>Marital status</i>			
Never married	394	46.7	41.2
Married and living with spouse	309	36.6	41.7
Divorced	89	10.6	7.4
Separated	23	2.7	2.9
Widowed	28	3.3	6.8
(Not answered)	1	0.1	–
<i>Relationship status</i>			
Currently in a relationship (including 'married and living with spouse')	527	62.4	
<i>Number of adults (age ≥ 16) in the household</i>			
1	202	23.9	
2	393	46.6	
3	146	17.3	
4 or more	103	12.2	
<i>Number of children (age < 16) in the household</i>			
0	633	75.0	
1	113	13.4	
2	71	8.4	
3	23	2.7	
4 or more	4	0.5	

† Comparator data for those aged 16+ from Office for National Statistics (2007a) except marital status from Office for National Statistics (nd).

Table D.4: Education and employment, London web survey

	# of respondents	% of respondents	% of respondents of working age	% in London population of working age†
<i>Work status</i>				
In paid employment (full- or part-time)	318	37.7	42.4	58.6
Self employed	85	10.1	9.9	10.9
In full-time education	88	10.4		
Unemployed and seeking work	79	9.4	10.7	7.7
Looking after family or home	52	6.2		
Long-term sick or disabled	66	7.8		
Retired from paid work altogether	128	15.2		
On a government training scheme	1	0.1		
Caring for a sick, elderly or disabled person	5	0.6		
On maternity leave	7	0.8		
Other	15	1.8		
<i>Qualifications</i>				
None	80	9.5	6.4	13.0
Below degree level	393	46.6	49.2	59.0
Degree level and above	371	44.0	44.4	28.0

† Comparator data from Office for National Statistics (2007a) applies to men aged 16 – 64 and women aged 16 – 59.

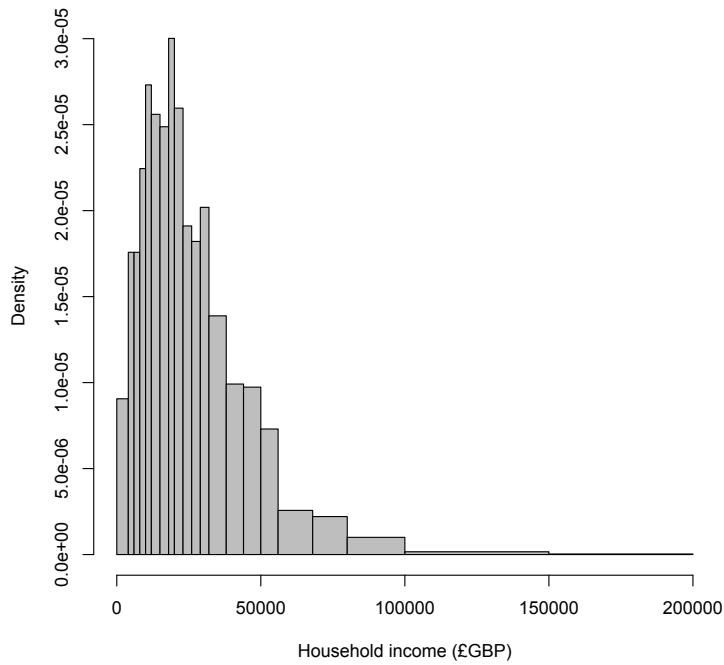


Figure D.1: Distribution of gross annual household income, UK web survey (bars span survey response brackets, and three respondents with a household income of £200,000 or more are not shown)

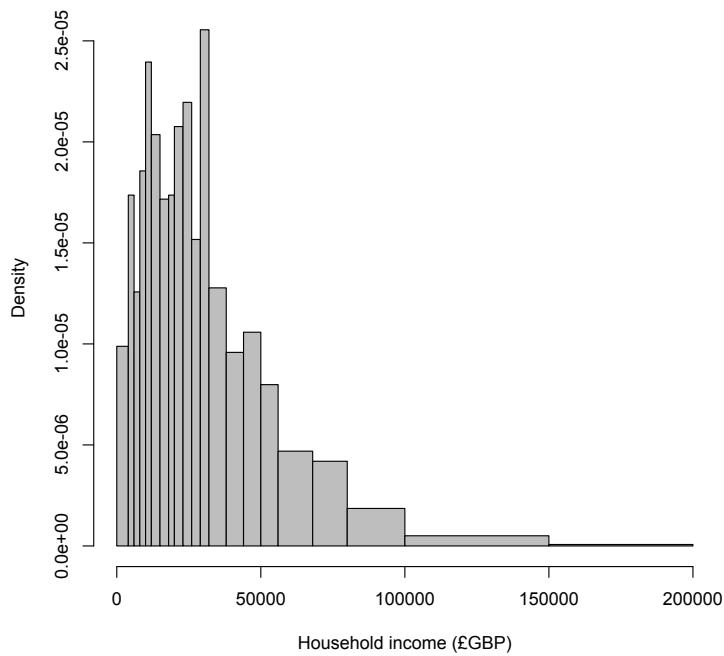


Figure D.2: Distribution of gross annual household income, London web survey (bars span survey response brackets, and three respondents with a household income of £200,000 – £399,999 are not shown)

D.2.2 PANAS

The PANAS is introduced as follows:

Here are a number of words that describe different feelings and emotions. For each item, please indicate to what extent you have felt this way during the past few weeks.

For each word, respondents pick one of five options, which are coded as follows:

Very slightly or not at all = 1

A little = 2

Moderately = 3

Quite a bit = 4

Extremely = 5

The positive sub-scale runs from 10 – 50 and is calculated as $10 \times$ the mean of the responses to the positive words: *interested, alert, excited, inspired, strong, determined, attentive, active, enthusiastic and proud*. Similarly, the negative sub-scale runs from 10 – 50 and is calculated as $10 \times$ the mean of the responses to the negative words: *irritable, distressed, ashamed, upset, nervous, guilty, scared, hostile, jittery and afraid* (McDowell, 2006, p. 226).

D.2.3 European Social Survey Wellbeing Module

We use the satisfying life, personal wellbeing, and personal and social wellbeing scales calculated from responses to our ESS Wellbeing Module items.

The satisfying life scale is calculated as the mean of five survey item response z-scores, which are coded so that higher responses indicate higher wellbeing.

The personal wellbeing scale is the mean of five lower-level scales — emotional wellbeing, satisfying life, vitality, resilience and self-esteem, and positive functioning — which are themselves calculated as the means of various item response z-scores.

The personal and social wellbeing scale is calculated as the mean of the personal wellbeing and social wellbeing scales. The social wellbeing scale is calculated as the mean of two lower-level scales — supportive relationships and trust and belonging — which are themselves calculated as the means of item response z-scores.

Full details of the ESS scale calculations are given by Michaelson et al. (2009)¹.

¹Note, however, that there is an error in the last two rows of the table in Appendix 3 on page 64 of Michaelson et al. (2009): the aligned scale for the last question, on appropriate pay, should be marked as '(inv)', while the penultimate question, on the likelihood of unemployment, should *not* be so marked.

D.3 Standardised coefficients for basic life satisfaction OLS regressions

Standardised coefficients for the basic OLS regressions seen in Tables 7.7 and 7.8 are presented here, in Tables D.5 and D.6 respectively.

Table D.5: Basic life satisfaction OLS regressions, UK: standardised coefficients

Variable	Standardised coeff.	Standardised coeff.	Standardised coeff.
% LCM NEA category within...			
Marine and coastal margins	0.0077	0.031	-0.0035
Freshwater, wetlands and floodplains	0.034*	0.043*	0.033+
Mountains, moors and heathlands	0.011	-0.021	0.0039
Semi-natural grasslands	0.038+	0.063**	0.073**
Enclosed farmland	-0.0022	0.054	0.034
Woodland	0.0097	0.059*	-0.025
Suburban/rural developed	0.044+	0.043	0.022
Inland bare ground	0.012	-0.012	-0.019
<i>Distance, ln(m)</i>			
National Park	-0.013	-0.0023	-0.013
AONB	0.00099	0.012	-0.0060
NNR	0.016	0.017	0.013
Coast	0.0087	0.00074	-0.0089
River	-0.011	-0.0029	-0.0063
Motorway	0.021	0.024	0.017
Railway station	-0.012	-0.014	-0.011
Pop. density (km ² , people/ha)	0.028	0.068*	0.030
House price (std. local median)	-0.0086	-0.019	-0.0040
Poor health	-0.29***	-0.29***	-0.29***
Good health	0.19***	0.19***	0.19***
Social tenant	0.050*	0.050*	0.053*
Equivalised household income, ln(£)	0.11***	0.11***	0.11***
Male	-0.022	-0.020	-0.022
Age	-0.56***	-0.55***	-0.56***
Age squared	0.70***	0.69***	0.70***
Unemployed	-0.13***	-0.12***	-0.13***
Lives alone	-0.11***	-0.11***	-0.11***
Religious	0.086***	0.088***	0.084***
Observations	1848	1848	1848
Adjusted R-squared	26.0%	26.4%	26.2%

Dependent variable: life satisfaction self-rating, 0 – 10.

Standard errors are sandwich estimators.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table D.6: Basic life satisfaction OLS regressions, London: standardised coefficients

Variable	Standardised coeff.	Standardised coeff.	Standardised coeff.
% green or blue space within...	200m	1km	3km
LCM green space	-0.012	-0.053	0.016
LCM freshwater, wetlands and floodplains	0.0041	-0.061+	-0.0034
Annual average PM10 level ($\mu\text{g}/\text{m}^3$)	0.036	0.033	0.042
LHR noise, $L_{\text{eq}} < 57 \text{ dB(A)}$	-0.050+	-0.050+	-0.049+
Road noise, $L_{\text{den}} < 55 \text{ dB(A)}$	0.016	0.014	0.019
Rail noise, $L_{\text{den}} < 55 \text{ dB(A)}$	-0.015	-0.016	-0.014
Distance from Zone 1, ln(m)	0.033	0.038	0.026
Distance to Tube/station, ln(m)	-0.034	-0.016	-0.039
Residential burglaries (LSOA, per 1,000 hhs.)	0.038	0.033	0.039
Violence against the person (LSOA, per 1,000 pop.)	-0.011	-0.013	-0.011
House price (std. local median)	0.026	0.034	0.025
Poor health	-0.28***	-0.29***	-0.28***
Good health	0.13***	0.13***	0.13***
Social tenant	0.00024	0.00098	0.00074
Equivalised household income, ln(£)	0.17***	0.17***	0.17***
Male	0.031	0.031	0.030
Age	-0.78***	-0.79***	-0.77***
Age squared	0.87***	0.89***	0.87***
Degree	-0.054	-0.055+	-0.053
Unemployed	-0.14***	-0.14***	-0.14***
Not in a relationship	-0.063+	-0.064*	-0.062+
Divorced or separated	-0.011	-0.011	-0.011
Religious	0.12***	0.12***	0.12***
Observations	810	810	810
Adjusted R-squared	25.1%	25.7%	25.1%

Dependent variable: life satisfaction self-rating, 0 – 10.

Standard errors are sandwich estimators.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D.4 Sample ordered probit model estimates

Sample estimates from an ordered probit model are shown in [Table D.7](#).

Table D.7: Example life satisfaction regression using ordered probit, UK

Variable	Coeff.	Std. err.
<i>% LCM NEA category within 3km</i>		
Marine and coastal margins	0.0058	(0.0059)
Freshwater, wetlands and floodplains	0.023+	(0.012)
Mountains, moors and heathlands	-0.012	(0.011)
Semi-natural grasslands	0.011**	(0.0035)
Enclosed farmland	0.0022	(0.0020)
Woodland	0.0085*	(0.0041)
Suburban/rural developed	0.0023	(0.0018)
Inland bare ground	-0.012	(0.013)
<i>Distance, ln(m)</i>		
National Park	-0.0036	(0.020)
AONB	0.0064	(0.017)
NNR	0.033	(0.033)
Coast	-0.00041	(0.017)
River	-0.0027	(0.022)
Motorway	0.015	(0.020)
Railway station	-0.019	(0.026)
Pop. density (km^2 , people/ha)	0.0027+	(0.0014)
House price (std. local median)	-0.078	(0.079)
Poor health	-0.68***	(0.064)
Good health	0.52***	(0.055)
Social tenant	0.17*	(0.071)
Equivalised household income, $\ln(\mathcal{E})$	0.15***	(0.037)
Male	-0.058	(0.049)
Age	-0.047***	(0.010)
Age squared	0.00062***	(0.00011)
Unemployed	-0.57***	(0.10)
Lives alone	-0.30***	(0.064)
Religious	0.22***	(0.054)
Cut-points	Not shown	
Observations	1848	
McFadden's pseudo R-squared	7.4%	

Dependent variable: life satisfaction self-rating, 0 – 10.

Standard errors are sandwich estimators.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix E

Supplementary information for experience sampling results

E.1 UK Time Use Survey 2000 activities classification

This classification is reproduced from [Office for National Statistics \(2003b\)](#).

Time Use Activity coding list for the UK

This coding frame follows that developed by Eurostat for the Harmonised European Time Use Study. Some adaptions to the wording have been made to make codes more understandable within the UK and 4 digit codes have been added in areas of particular interest to the UK. When the data was coded a 0 was added to the 3 digit code so that all entries have 4 digits, although SPSS ignores leading zeroes, so 010 'Unspecified sleep' appears on the data file as 100 and 100 'Unspecified employment' appears as 1000.

Main and secondary activities

0 PERSONAL CARE

000 Unspecified personal care

01 SLEEP

010 Unspecified sleep
011 Sleep
012 Sick in bed

02 EATING

021 Eating

03 OTHER PERSONAL CARE

030 Unspecified other personal care
031 Wash and dress
039 Other specified personal care

1 EMPLOYMENT

100 Unspecified employment

11 MAIN JOB

111 Working time in main job
112 Coffee and other breaks in main job

12 SECOND JOB

121 Working time in second job
122 Coffee and other breaks in second job

13 ACTIVITIES RELATED TO EMPLOYMENT

130 Unspecified activities related to employment
131 Lunch break
139 Other specified activities related to employment
1391 Activities related to job seeking
1399 Other specified activities related to employment

2 STUDY

200 Unspecified study

21 SCHOOL OR UNIVERSITY

210 Unspecified activities related to school or university
211 Classes and lectures
212 Homework
219 Other specified activities related to school or university

22 FREE TIME STUDY

221 Free time study

3 HOUSEHOLD AND FAMILY CARE

300 Unspecified household and family care

31 FOOD MANAGEMENT

310 Unspecified food management
311 Food preparation
312 Baking
313 Dish washing
314 Preserving
319 Other specified food management

32 HOUSEHOLD UPKEEP

320 Unspecified household upkeep
321 Cleaning dwelling
322 Cleaning yard
323 Heating and water
324 Various arrangements
325 Disposal of waste
329 Other specified household upkeep

33 MAKING AND CARE FOR TEXTILES

330 Unspecified making and care for textiles
331 Laundry
332 Ironing
333 Handicraft and producing textiles
339 Other specified making and care for textiles

34 GARDENING AND PET CARE

340 Unspecified gardening and pet care
341 Gardening
342 Tending domestic animals
343 Caring for pets
344 Walking the dog
349 Other specified gardening and pet care

35 CONSTRUCTION AND REPAIRS

350 Unspecified construction and repairs
351 House construction and renovation
352 Repairs of dwelling
353 Making, repairing and maintaining equipment
3530 Unspecified making, repairing and maintaining equipment
3531 Woodcraft, metalcraft, sculpture and pottery
3539 Other specified making, repairing and maintaining equipment
354 Vehicle maintenance
359 Other specified construction and repairs

36 SHOPPING AND SERVICES

360 Unspecified shopping and services
361 Shopping
3610 Unspecified shopping
3611 Shopping mainly for food
3612 Shopping mainly for clothing
3613 Shopping mainly related to accommodation
3614 Shopping or browsing at car boot sales or antique fairs
3615 Window shopping or other shopping as leisure
3619 Other specified shopping
362 Commercial and administrative services
363 Personal services
369 Other specified shopping and services

- 37 HOUSEHOLD MANAGEMENT**
- 371 Household management not using the internet
 - 372 Household management using the internet
 - 3720 Unspecified household management using the internet
 - 3721 Shopping for and ordering unspecified goods and services via the internet
 - 3722 Shopping for and ordering food via the internet
 - 3723 Shopping for and ordering clothing via the internet
 - 3724 Shopping for and ordering goods and services related to accommodation via the internet
 - 3725 Shopping for and ordering mass media via the internet
 - 3726 Shopping for and ordering entertainment via the internet
 - 3727 Banking and bill paying via the internet
 - 3729 Other specified household management using the internet
- 38 CHILDCARE OF OWN HOUSEHOLD MEMBERS**
- 380 Unspecified childcare
 - 381 Physical care and supervision
 - 3810 Unspecified physical care & supervision of a child
 - 3811 Feeding the child
 - 3819 Other specified physical care & supervision of a child
 - 382 Teaching the child
 - 383 Reading, playing and talking with child
 - 384 Accompanying child
 - 389 Other specified childcare
- 39 HELP TO AN ADULT HOUSEHOLD MEMBER**
- 391 Help to an adult household member
 - 3910 Unspecified help to an adult household member
 - 3911 Physical care & supervision of an adult household member
 - 3914 Accompanying an adult household member
 - 3919 Other specified help to an adult household member

4 VOLUNTEER WORK AND MEETINGS

400 Unspecified volunteer work and meetings

41 ORGANISATIONAL WORK

410 Unspecified organisational work
411 Work for an organisation
412 Volunteer work through an organisation
419 Other specified organisational work

42 INFORMAL HELP TO OTHER HOUSEHOLDS

420 Unspecified informal help
421 Food management as help
422 Household upkeep as help
423 Gardening and pet care as help
424 Construction and repairs as help
425 Shopping and services as help
426 Help in employment and farming
427 Childcare as help
 4270 Unspecified childcare as help
 4271 Physical care and supervision of a child as help
 4272 Teaching the child as help
 4273 Reading, playing & talking to the child as help
 4274 Accompanying the child as help
 4279 Other specified childcare as help
428 Help to an adult of another household
 4280 Unspecified help to an adult member of another household
 4281 Physical care and supervision of an adult as help
 4284 Accompanying an adult as help
 4289 Other specified help to an adult member of another household
429 Other specified informal help

43 PARTICIPATORY ACTIVITIES

430 Unspecified participatory activities
431 Meetings
432 Religious activities
439 Other specified participatory activities

5 SOCIAL LIFE AND ENTERTAINMENT

500 Unspecified social life and entertainment

51 SOCIAL LIFE

- 510 Unspecified social life
- 511 Socialising with household members
- 512 Visiting and receiving visitors
- 513 Feasts
- 514 Telephone conversation
- 519 Other specified social life

52 ENTERTAINMENT AND CULTURE

- 520 Unspecified entertainment and culture
- 521 Cinema
- 522 Theatre and concerts
 - 5220 Unspecified theatre or concerts
 - 5221 Plays, musicals or pantomimes
 - 5222 Opera, operetta or light opera
 - 5223 Concerts or other performances of classical music
 - 5224 Live music other than classical concerts, opera and musicals
 - 5225 Dance performances
 - 5229 Other specified theatre or concerts
- 523 Art exhibitions and museums
- 524 Library
 - 5240 Unspecified library
 - 5241 Borrowing books, records, audiotapes, videotapes, CDs, VDs etc. from a library
 - 5242 Reference to books and other library materials within a library
 - 5243 Using internet in the library
 - 5244 Using computers in the library other than internet use
 - 5245 Reading newspapers in a library
 - 5246 Listening to music in a library
 - 5249 Other specified library activities
- 525 Sports events
- 529 Other specified entertainment and culture
 - 5291 Visiting a historical site
 - 5292 Visiting a wildlife site
 - 5293 Visiting a botanical site
 - 5294 Visiting a leisure park
 - 5295 Visiting an urban park, playground or designated play area
 - 5299 Other specified entertainment or culture

53 RESTING – TIME OUT

531 Resting – Time out

6 SPORTS AND OUTDOOR ACTIVITIES

600 Unspecified sports and outdoor activities

61 PHYSICAL EXERCISE

- 610 Unspecified physical exercise
- 611 Walking and hiking
 - 6111 Taking a walk or hike that lasts at least 2 miles or 1 hour
 - 6119 Other walk or hike
- 612 Jogging and running
- 613 Biking, skiing and skating
 - 6131 Biking
 - 6132 Skiing or skating
- 614 Ball games
 - 6140 Unspecified ball games
 - 6141 Indoor pairs or doubles games
 - 6142 Indoor team games
 - 6143 Outdoor pairs or doubles games
 - 6144 Outdoor team games
 - 6149 Other specified ball games
- 615 Gymnastics
- 616 Fitness
- 617 Water sports
 - 6170 Unspecified water sports
 - 6171 Swimming
 - 6179 Other specified water sports
- 619 Other specified physical exercise

62 PRODUCTIVE EXERCISE

- 620 Unspecified productive exercise
- 621 Hunting and fishing
- 622 Picking berries, mushroom and herbs
- 629 Other specified productive exercise

63 SPORTS RELATED ACTIVITIES

- 631 Sports related activities
 - 6310 Unspecified sports related activities
 - 6311 Activities related to sports
 - 6312 Activities related to productive exercise

7 HOBBIES AND GAMES

700 Unspecified hobbies and games

71 ARTS

710 Unspecified arts

711 Visual arts

7110 Unspecified visual arts

7111 Painting, drawing or other graphic arts

7112 Making videos, taking photographs or related photographic activities

7119 Other specified visual arts

712 Performing arts

7120 Unspecified performing arts

7121 Singing or other musical activities

7129 Other specified performing arts

713 Literary arts

719 Other specified arts

72 HOBBIES

720 Unspecified hobbies

721 Collecting

722 Computing – programming

723 Information by computing

7230 Unspecified information by computing

7231 Information searching on the internet

7239 Other specified information by computing

724 Communication by computing

7240 Unspecified communication by computer

7241 Communication on the internet

7249 Other specified communication by computing

725 Other computing

7250 Unspecified other computing

7251 Unspecified internet use

7259 Other specified computing

726 Correspondence

729 Other specified hobbies

73 GAMES

730 Unspecified games

731 Solo games and play

732 Games and play with others

7320 Unspecified games and play with others

7321 Billiards, pool, snooker or petanque

7322 Chess and bridge

7329 Other specified parlour games and play

733 Computer games

734 Gambling

739 Other specified games

8 MASS MEDIA

800 Unspecified mass media

81 READING

810 Unspecified reading
811 Reading periodicals
812 Reading books
819 Other specified reading

82 TV AND VIDEO

821 Watching TV
8210 Unspecified TV watching
8211 Watching a film on TV
8212 Watching sport on TV
8219 Other specified TV watching
822 Watching video
8220 Unspecified video watching
8221 Watching a film on video
8222 Watching sport on video
8229 Other specified video watching

83 RADIO AND MUSIC

830 Unspecified listening to radio and music
831 Listening to radio
8310 Unspecified radio listening
8311 Listening to music on the radio
8312 Listening to sport on the radio
8319 Other specified radio listening
832 Listening to recordings

TRAVEL AND UNSPECIFIED TIME USE**90 TRAVEL BY PURPOSE**

- 900 Travel related to unspecified time use
 - 901 Travel related to personal business
 - 911 Travel in the course of work
 - 913 Travel to work from home and back only
 - 914 Travel to work from a place other than home
 - 921 Travel related to education
 - 923 Travel escorting to/ from education
 - 931 Travel related to household care
 - 936 Travel related to shopping
 - 937 Travel related to services
 - 938 Travel escorting a child (other than education)
 - 939 Travel escorting an adult (other than education)
 - 941 Travel related to organisational work
 - 942 Travel related to informal help to other households
 - 943 Travel related to religious activities
 - 944 Travel related to participatory activities other than religious activities
 - 950 Travel to visit friends/ relatives in their homes (not respondent's household)
 - 951 Travel related to other social activities
 - 952 Travel related to entertainment and culture
 - 961 Travel related to physical exercise
 - 962 Travel related to hunting & fishing
 - 963 Travel related to productive exercise other than hunting & fishing
 - 971 Travel related to gambling
 - 972 Travel related to hobbies other than gambling
 - 981 Travel to holiday base
 - 982 Travel for day trip/ just walk
 - 989 Other specified travel
-
- 994 Punctuating activity
 - 995 Filling in the time use diary
 - 996 No main activity, no idea what it might be
 - 997 No main activity, some idea what it might be
 - 998 Illegible activity
 - 999 Unspecified time use

E.2 Response counts by device

ESM response counts by device are shown in Table E.1.

Table E.1: Response counts by device

<i>Device code</i>	<i>Device name</i>	<i>GPS + mobile data</i>	<i># of all responses</i>	<i>% of all responses</i>	<i># of valid responses</i>	<i>% of valid responses</i>
iPhone2,1	iPhone 3GS	✓	955,641	48.65	563,260	49.47
iPhone3,1	iPhone 4	✓	666,815	33.95	391,176	34.36
iPhone1,2	iPhone 3G	✓	293,912	14.96	170,416	14.97
iPod2,1	iPod, 2nd gen		19,555	1.00	5,123	0.45
iPod3,1	iPod, 3rd gen		10,264	0.52	3,130	0.27
iPad1,1	iPad (original)	varies	8,169	0.42	2,067	0.18
iPod4,1	iPod, 4th gen		6,859	0.35	2,382	0.21
iPhone1,1	iPhone (original)	data only	1,578	0.08	611	0.05
iPod1,1	iPod, 1st gen		1,524	0.08	316	0.03
iPhone3,3*	iPhone 4 (Verizon)	✓	9	0.00	0	0.00

* iPhone3,3 was released on 10 February 2010 — 12 days before our data snapshot was taken — and on one network in the United States only.

E.3 ESM fixed effects model building

Table E.2 presents estimates for fixed effects model specifications predicting happiness (a) from spatial variables only, and (b) from spatial variables plus the other control variables included in the ESM assessment (but excluding time/day and sequence controls).

Table E.2: ESM fixed effects model building

Variable	Spatial variables only			Spatial plus ESM survey vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Location</i>						
Indoors (base cat.)	—			—		
In a vehicle	-1.12	(0.097)	< 0.0001	-0.17	(0.14)	0.2248
Outdoors	2.83	(0.48)	< 0.0001	2.24	(0.45)	< 0.0001
At home (base cat.)	—			—		
At work				-2.67	(0.12)	< 0.0001
Elsewhere				1.82	(0.086)	< 0.0001
<i>Land cover type when participant is outdoors</i>						
Continuous urban (base cat.)	—			—		
Marine and coastal margins	10.10	(0.78)	< 0.0001	6.17	(0.69)	< 0.0001
Mountains, moors and heathland	5.30	(0.95)	< 0.0001	2.82	(0.87)	0.0013
Woodland	5.08	(0.37)	< 0.0001	2.26	(0.34)	< 0.0001
Semi-natural grasslands	4.62	(0.39)	< 0.0001	2.14	(0.35)	< 0.0001
Enclosed farmland	4.64	(0.27)	< 0.0001	2.08	(0.24)	< 0.0001
Freshwater, wetlands and flood plains	4.38	(0.70)	< 0.0001	1.94	(0.63)	0.0021
Suburban/rural developed	1.53	(0.17)	< 0.0001	0.88	(0.16)	< 0.0001
Inland bare ground	0.75	(0.52)	0.1484	0.38	(0.47)	0.4206
<i>Daylight & weather when participant is outdoors</i>						
Daylight	-1.65	(0.19)	< 0.0001	0.080	(0.17)	0.6414
Snow	0.68	(0.76)	0.3705	0.92	(0.72)	0.2026
Sun	0.46	(0.20)	0.0202	0.23	(0.18)	0.2159
Fog	-2.04	(0.57)	0.0004	-1.61	(0.54)	0.0031
Rain	-2.36	(0.24)	< 0.0001	-1.47	(0.22)	< 0.0001
< 0 °C (base category)	—			—		
0 – < 8 °C	0.061	(0.44)	0.8891	-0.45	(0.41)	0.2765
8 – < 16 °C	1.73	(0.45)	0.0001	0.091	(0.42)	0.8282
16 – < 24 °C	2.96	(0.46)	< 0.0001	0.59	(0.43)	0.1653
24+ °C	7.14	(1.27)	< 0.0001	4.52	(1.22)	0.0002
0 – < 5 km/h windspeed (base cat.)	—			—		
5 – < 15 km/h windspeed	-0.21	(0.20)	0.3071	-0.12	(0.19)	0.5120
15 – < 25 km/h windspeed	-0.44	(0.21)	0.0401	-0.33	(0.20)	0.0973
25+ km/h windspeed	-1.36	(0.27)	< 0.0001	-0.75	(0.25)	0.0027
<i>Activities</i>						
Intimacy, making love				13.20	(0.32)	< 0.0001
Sports, running, exercise				6.47	(0.19)	< 0.0001
Theatre, dance, concert				6.39	(0.31)	< 0.0001
Singing, performing				5.85	(0.35)	< 0.0001

continues ...

... *continued*

Variable	Spatial variables only			Spatial plus ESM survey vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
Exhibition, museum, library	5.76	(0.36)	< 0.0001			
Hobbies, arts, crafts	5.37	(0.20)	< 0.0001			
Talking, chatting, socialising	4.53	(0.076)	< 0.0001			
Birdwatching, nature watching	4.69	(0.62)	< 0.0001			
Drinking alcohol	4.08	(0.10)	< 0.0001			
Meditating, religious activities	3.82	(0.47)	< 0.0001			
Listening to music	3.60	(0.098)	< 0.0001			
Gardening, allotment	3.77	(0.44)	< 0.0001			
Hunting, fishing	3.46	(1.33)	0.0095			
Pet care, playing with pets	3.21	(0.21)	< 0.0001			
Childcare, playing with children	3.02	(0.17)	< 0.0001			
Computer games, iPhone games	2.97	(0.12)	< 0.0001			
Walking, hiking	2.58	(0.18)	< 0.0001			
Other games, puzzles	2.37	(0.26)	< 0.0001			
Watching TV, film	2.55	(0.28)	< 0.0001			
Match, sporting event	2.40	(0.067)	< 0.0001			
Eating, snacking	2.20	(0.062)	< 0.0001			
Cooking, preparing food	2.11	(0.098)	< 0.0001			
Washing, dressing, grooming	1.74	(0.11)	< 0.0001			
Listening to speech/podcast	1.90	(0.15)	< 0.0001			
Gambling, betting	1.90	(0.72)	0.0085			
Reading	1.70	(0.11)	< 0.0001			
Drinking tea/coffee	1.59	(0.11)	< 0.0001			
Shopping, errands	1.17	(0.11)	< 0.0001			
Sleeping, resting, relaxing	0.92	(0.087)	< 0.0001			
Texting, email, social media	0.89	(0.13)	< 0.0001			
Browsing the Internet	0.95	(0.10)	< 0.0001			
Smoking	0.14	(0.20)	0.5029			
In a meeting, seminar, class	0.11	(0.17)	0.5267			
Housework, chores, DIY	-0.68	(0.10)	< 0.0001			
Something else (app version < 1.0.2)	-1.63	(0.16)	< 0.0001			
Admin, finances, organising	-1.80	(0.16)	< 0.0001			
Working, studying	-1.82	(0.095)	< 0.0001			
Travelling, commuting	-2.22	(0.12)	< 0.0001			
Something else (app version ≥ 1.0.2)	-3.01	(0.19)	< 0.0001			
Care or help for adults	-3.96	(0.60)	< 0.0001			
Waiting, queueing	-4.09	(0.15)	< 0.0001			
Sick in bed	-19.50	(0.29)	< 0.0001			
<i>Companionship</i>						
Spouse, partner, girl/boyfriend	4.71	(0.11)	< 0.0001			
Friends	4.48	(0.092)	< 0.0001			
Other family members	0.88	(0.10)	< 0.0001			
Clients, customers	0.53	(0.41)	0.1945			
Children	0.34	(0.15)	0.0221			
Colleagues, classmates	-0.30	(0.13)	0.0174			

continues ...

... continued

Variable	Spatial variables only			Spatial plus ESM survey vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
Other people participant knows				-0.79	(0.20)	0.0001
Participant-level fixed effects	Yes			Yes		
Constant (mean fixed effect)	66.20	(0.011)	< 0.0001	63.20	(0.081)	< 0.0001
Observations	1138481			1138481		
Groups (participants)	21947			21947		
R ² (within groups)	0.6%			13.1%		

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Explanatory variables are listed in the same order as in the main fixed effects model.

E.4 ESM fixed effects model with month dummies

Table E.3 repeats the main land cover model with the addition of month dummy variables.

Table E.3: Land cover model with month dummies

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Location</i>			
Indoors (base category)	—		
In a vehicle	-0.17	-0.14	0.218
Outdoors	2.25	-0.44	< 0.001
At home (base category)	—		
At work	-2.59	-0.12	< 0.001
Elsewhere	1.73	-0.086	< 0.001
<i>Land cover type when participant is outdoors</i>			
Continuous urban (base category)	—		
Marine and coastal margins	6.02	-0.68	< 0.001
Mountains, moors and heathland	2.72	-0.87	0.002
Woodland	2.12	-0.34	< 0.001
Semi-natural grasslands	2.04	-0.35	< 0.001
Enclosed farmland	2.03	-0.24	< 0.001
Freshwater, wetlands and flood plains	1.81	-0.63	0.004
Suburban/rural developed	0.88	-0.16	< 0.001
Inland bare ground	0.36	-0.47	0.437
<i>Daylight & weather when participant is outdoors</i>			
Daylight	-0.12	-0.17	0.498
Snow	1.01	-0.72	0.162
Sun	0.47	-0.18	0.012
Fog	-1.36	-0.54	0.012
Rain	-1.37	-0.22	< 0.001
< 0 °C (base category)	—		
0 – < 8 °C	-0.45	-0.41	0.272
8 – < 16 °C	0.39	-0.41	0.339
16 – < 24 °C	1.06	-0.42	0.012
24+ °C	5.19	-1.21	< 0.001
0 – < 5 km/h windspeed (base category)	—		
5 – < 15 km/h windspeed	-0.20	-0.19	0.292
15 – < 25 km/h windspeed	-0.51	-0.2	0.01
25+ km/h windspeed	-0.93	-0.25	< 0.001
<i>Activities</i>			
Intimacy, making love	12.9	-0.32	< 0.001
<i>continues ...</i>			

... *continued*

<i>Variable</i>	<i>Coeff.</i>	<i>Std. err.</i>	<i>Pr(coeff. = 0)</i>
Sports, running, exercise	6.51	-0.19	< 0.001
Theatre, dance, concert	6.49	-0.31	< 0.001
Singing, performing	5.87	-0.33	< 0.001
Exhibition, museum, library	5.59	-0.36	< 0.001
Hobbies, arts, crafts	5.29	-0.21	< 0.001
Talking, chatting, socialising	4.46	-0.076	< 0.001
Birdwatching, nature watching	4.35	-0.62	< 0.001
Drinking alcohol	4.12	-0.11	< 0.001
Meditating, religious activities	3.66	-0.47	< 0.001
Listening to music	3.55	-0.098	< 0.001
Gardening, allotment	3.55	-0.44	< 0.001
Hunting, fishing	3.27	-1.36	0.016
Pet care, playing with pets	3.18	-0.21	< 0.001
Childcare, playing with children	3.00	-0.17	< 0.001
Computer games, iPhone games	2.97	-0.12	< 0.001
Walking, hiking	2.55	-0.18	< 0.001
Other games, puzzles	2.34	-0.26	< 0.001
Watching TV, film	2.29	-0.069	< 0.001
Match, sporting event	2.29	-0.28	< 0.001
Eating, snacking	2.22	-0.062	< 0.001
Cooking, preparing food	2.15	-0.097	< 0.001
Washing, dressing, grooming	2.01	-0.11	< 0.001
Listening to speech/podcast	1.97	-0.15	< 0.001
Gambling, betting	1.93	-0.71	0.007
Reading	1.71	-0.11	< 0.001
Drinking tea/coffee	1.41	-0.11	< 0.001
Shopping, errands	0.97	-0.11	< 0.001
Sleeping, resting, relaxing	0.95	-0.087	< 0.001
Texting, email, social media	0.77	-0.13	< 0.001
Browsing the Internet	0.77	-0.1	< 0.001
Smoking	0.16	-0.2	0.428
In a meeting, seminar, class	0.07	-0.17	0.695
Housework, chores, DIY	-0.87	-0.1	< 0.001
Something else (app version < 1.0.2)	-1.41	-0.15	< 0.001
Admin, finances, organising	-1.72	-0.16	< 0.001
Working, studying	-1.91	-0.096	< 0.001
Travelling, commuting	-2.03	-0.12	< 0.001
Something else (app version \geq 1.0.2)	-3.25	-0.19	< 0.001
Care or help for adults	-3.96	-0.6	< 0.001
Waiting, queueing	-4.10	-0.15	< 0.001

continues ...

... continued

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
Sick in bed	-19.70	-0.29	< 0.001
<i>Companionship</i>			
Spouse, partner, girl/boyfriend	4.51	-0.11	< 0.001
Friends	4.38	-0.092	< 0.001
Other family members	0.74	-0.1	< 0.001
Clients, customers	0.43	-0.41	0.292
Children	0.27	-0.15	0.072
Colleagues, classmates	-0.29	-0.13	0.025
Other people participant knows	-0.83	-0.19	< 0.001
<i>Time of day, day of week dummies</i>			
Mon – Fri, midnight – < 3am	3.00	-0.44	< 0.001
Mon – Fri, 3am – < 6am	-0.56	-1.16	0.628
Mon – Fri, 6am – < 9am (base category)	—		
Mon – Fri, 9am – < noon	3.19	-0.12	< 0.001
Mon – Fri, noon – < 3pm	3.57	-0.12	< 0.001
Mon – Fri, 3pm – < 6pm	3.43	-0.12	< 0.001
Mon – Fri, 6pm – < 9pm	2.80	-0.13	< 0.001
Mon – Fri, 9pm – < midnight	3.15	-0.14	< 0.001
Sat – Sun, midnight – < 3am	4.51	-0.67	< 0.001
Sat – Sun, 3am – < 6am	2.26	-1.67	0.176
Sat – Sun, 6am – < 9am	2.88	-0.21	< 0.001
Sat – Sun, 9am – < noon	4.27	-0.14	< 0.001
Sat – Sun, noon – < 3pm	4.31	-0.14	< 0.001
Sat – Sun, 3pm – < 6pm	4.07	-0.14	< 0.001
Sat – Sun, 6pm – < 9pm	4.11	-0.14	< 0.001
Sat – Sun, 9pm – < midnight	4.03	-0.16	< 0.001
<i>Month</i>			
August 2010	-0.072	(0.32)	0.820
September	-0.062	(0.28)	0.824
October	-0.25	(0.24)	0.304
November	-0.21	(0.22)	0.341
December	0.02	(0.18)	0.914
January 2011 (base category)	—		
February	-0.17	(0.20)	0.385
<i>Participant's response number</i>			
Response #1	-5.77	-0.68	< 0.001
Response #2 – #11	-3.58	-0.15	< 0.001

continues ...

... *continued*

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
Response #12 – #51	-0.96	-0.11	< 0.001
Response #52+ (base category)	—		
Participant-level fixed effects		Yes	
Constant (mean fixed effect)	60.80	-0.23	< 0.001
Observations	1138481		
Groups (participants)	21947		
R ² (within groups)	13.5%		

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Explanatory variables are listed in the same order as in the main land cover model.

E.5 ESM interval regression models

Table E.4 presents the main land cover specification estimated using an interval regression model (Stata's INTREG), while Table E.5 presents the same specification estimated using random effects interval regression (Stata's XTINTREG).

Table E.4: Land cover interval regression model

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Location</i>			
Indoors (base category)			
In a vehicle	0.53	(0.27)	0.050
Outdoors	2.91	(0.66)	< 0.001
At home (base category)			
At work	-2.09	(0.24)	< 0.001
Elsewhere	1.64	(0.16)	< 0.001
<i>Land cover type when participant is outdoors</i>			
Continuous urban (base category)			
Marine and coastal margins	6.51	(0.98)	< 0.001
Mountains, moors and heathland	4.65	(1.17)	< 0.001
Woodland	2.74	(0.54)	< 0.001
Semi-natural grasslands	2.73	(0.50)	< 0.001
Enclosed farmland	3.32	(0.37)	< 0.001
Freshwater, wetlands and flood plains	2.33	(0.91)	0.011
Suburban/rural developed	1.36	(0.25)	< 0.001
Inland bare ground	0.43	(0.70)	0.540
<i>Daylight & weather when participant is outdoors</i>			
Daylight	-0.10	(0.24)	0.671
Snow	2.57	(1.02)	0.012
Sun	0.66	(0.24)	0.007
Fog	-1.49	(0.71)	0.036
Rain	-1.55	(0.29)	< 0.001
< 0 °C (base category)			
0 – < 8 °C	-0.81	(0.58)	0.161
8 – < 16 °C	0.20	(0.62)	0.752
16 – < 24 °C	1.15	(0.64)	0.075
24+ °C	5.76	(1.66)	0.001
0 – < 5 km/h windspeed (base category)			
5 – < 15 km/h windspeed	-0.22	(0.27)	0.433
15 – < 25 km/h windspeed	-0.51	(0.30)	0.090
25+ km/h windspeed	-0.74	(0.37)	0.044

continues ...

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<i>Variable</i>	<i>Coeff.</i>	<i>Std. err.</i>	<i>Pr(coeff. = 0)</i>
<i>Activities</i>			
Intimacy, making love	17.30	(0.56)	< 0.001
Sports, running, exercise	7.61	(0.36)	< 0.001
Theatre, dance, concert	7.64	(0.45)	< 0.001
Singing, performing	6.31	(1.25)	< 0.001
Exhibition, museum, library	5.27	(0.59)	< 0.001
Hobbies, arts, crafts	5.65	(0.45)	< 0.001
Talking, chatting, socialising	5.25	(0.17)	< 0.001
Birdwatching, nature watching	6.06	(1.09)	< 0.001
Drinking alcohol	5.01	(0.23)	< 0.001
Meditating, religious activities	5.28	(0.73)	< 0.001
Listening to music	4.02	(0.22)	< 0.001
Gardening, allotment	6.70	(1.09)	< 0.001
Hunting, fishing	5.89	(2.21)	0.008
Pet care, playing with pets	3.44	(0.52)	< 0.001
Childcare, playing with children	3.61	(0.45)	< 0.001
Computer games, iPhone games	2.94	(0.27)	< 0.001
Walking, hiking	2.75	(0.30)	< 0.001
Other games, puzzles	2.40	(0.45)	< 0.001
Watching TV, film	2.07	(0.17)	< 0.001
Match, sporting event	3.08	(0.48)	< 0.001
Eating, snacking	2.25	(0.13)	< 0.001
Cooking, preparing food	2.66	(0.21)	< 0.001
Washing, dressing, grooming	1.83	(0.22)	< 0.001
Listening to speech/podcast	1.48	(0.48)	0.002
Gambling, betting	3.56	(1.45)	0.014
Reading	1.32	(0.28)	< 0.001
Drinking tea/coffee	1.80	(0.29)	< 0.001
Shopping, errands	1.05	(0.21)	< 0.001
Sleeping, resting, relaxing	0.97	(0.21)	< 0.001
Texting, email, social media	-0.22	(0.28)	0.424
Browsing the Internet	-0.30	(0.25)	0.239
Smoking	-0.11	(0.69)	0.870
In a meeting, seminar, class	0.62	(0.30)	0.040
Housework, chores, DIY	-1.08	(0.22)	< 0.001
Something else (app version < 1.0.2)	-1.92	(0.30)	< 0.001
Admin, finances, organising	-2.03	(0.28)	< 0.001
Working, studying	-2.03	(0.21)	< 0.001
Travelling, commuting	-2.57	(0.24)	< 0.001
Something else (app version \geq 1.0.2)	-4.69	(0.55)	< 0.001

continues ...

... *continued*

<i>Variable</i>	<i>Coeff.</i>	<i>Std. err.</i>	<i>Pr(coeff. = 0)</i>
Care or help for adults	-3.26	(0.92)	< 0.001
Waiting, queueing	-5.16	(0.27)	< 0.001
Sick in bed	-22.50	(0.40)	< 0.001
<i>Companionship</i>			
Spouse, partner, girl/boyfriend	6.58	(0.22)	< 0.001
Friends	4.90	(0.19)	< 0.001
Other family members	1.11	(0.24)	< 0.001
Clients, customers	1.56	(0.56)	0.005
Children	0.75	(0.39)	0.057
Colleagues, classmates	-0.52	(0.23)	0.022
Other people participant knows	-1.59	(0.30)	< 0.001
<i>Time of day, day of week dummies</i>			
Mon – Fri, midnight – < 3am	1.87	(1.03)	0.069
Mon – Fri, 3am – < 6am	-2.76	(1.79)	0.122
Mon – Fri, 6am – < 9am (base category)	—		
Mon – Fri, 9am – < noon	3.06	(0.20)	< 0.001
Mon – Fri, noon – < 3pm	3.28	(0.21)	< 0.001
Mon – Fri, 3pm – < 6pm	3.18	(0.21)	< 0.001
Mon – Fri, 6pm – < 9pm	2.43	(0.21)	< 0.001
Mon – Fri, 9pm – < midnight	2.54	(0.25)	< 0.001
Sat – Sun, midnight – < 3am	4.70	(1.22)	< 0.001
Sat – Sun, 3am – < 6am	1.32	(2.19)	0.545
Sat – Sun, 6am – < 9am	3.04	(0.28)	< 0.001
Sat – Sun, 9am – < noon	4.06	(0.21)	< 0.001
Sat – Sun, noon – < 3pm	3.88	(0.22)	< 0.001
Sat – Sun, 3pm – < 6pm	3.70	(0.23)	< 0.001
Sat – Sun, 6pm – < 9pm	3.62	(0.23)	< 0.001
Sat – Sun, 9pm – < midnight	3.40	(0.28)	< 0.001
<i>Participant's response number</i>			
Response #1	-8.41	(0.78)	< 0.001
Response #2 – #11	-5.16	(0.21)	< 0.001
Response #12 – #51	-1.69	(0.19)	< 0.001
Response #52+ (base category)	—		
Constant	61.30	(0.35)	< 0.001
Total observations	1138481		
Left-censored observations	10582		
Right-censored observations	80994		

continues ...

... *continued*

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
Log pseudo-likelihood	-4824120		
Wald χ^2 (df)	20162 (91)		< 0.001

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Explanatory variables are listed in the same order as in the main land cover model.

Table E.5: Land cover random effects interval regression model

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Location</i>			
Indoors (base category)			
In a vehicle	-0.20	(0.11)	0.0545
Outdoors	2.54	(0.44)	< 0.001
At home (base category)			
At work	-2.67	(0.077)	< 0.001
Elsewhere	1.92	(0.061)	< 0.001
<i>Land cover type when participant is outdoors</i>			
Continuous urban (base category)			
Marine and coastal margins	7.24	(0.70)	< 0.001
Mountains, moors and heathland	3.25	(0.91)	0.0004
Woodland	2.57	(0.34)	< 0.001
Semi-natural grasslands	2.52	(0.31)	< 0.001
Enclosed farmland	2.44	(0.22)	< 0.001
Freshwater, wetlands and flood plains	2.25	(0.71)	0.0016
Suburban/rural developed	1.03	(0.15)	< 0.001
Inland bare ground	0.52	(0.46)	0.2636
<i>Daylight & weather when participant is outdoors</i>			
Daylight	-0.20	(0.17)	0.2535
Snow	1.66	(0.78)	0.0326
Sun	0.55	(0.20)	0.0058
Fog	-1.46	(0.53)	0.006
Rain	-1.53	(0.22)	< 0.001
< 0 °C (base category)			
0 – < 8 °C	-0.56	(0.43)	0.1926
8 – < 16 °C	0.31	(0.42)	0.4531
16 – < 24 °C	1.08	(0.42)	0.0103
24+ °C	6.20	(1.44)	< 0.001
0 – < 5 km/h windspeed (base category)			
5 – < 15 km/h windspeed	-0.25	(0.20)	0.2084
15 – < 25 km/h windspeed	-0.54	(0.20)	0.0084
25+ km/h windspeed	-1.02	(0.25)	0.0001
<i>Activities</i>			
Intimacy, making love	16.20	(0.26)	< 0.001
Sports, running, exercise	7.20	(0.18)	< 0.001
Theatre, dance, concert	7.50	(0.32)	< 0.001
Singing, performing	6.69	(0.27)	< 0.001

continues ...

... continued

Variable	Coeff.	Std. err.	Pr(coeff. = 0)
Exhibition, museum, library	6.20	(0.39)	< 0.001
Hobbies, arts, crafts	5.76	(0.18)	< 0.001
Talking, chatting, socialising	4.90	(0.057)	< 0.001
Birdwatching, nature watching	5.56	(0.71)	< 0.001
Drinking alcohol	4.80	(0.090)	< 0.001
Meditating, religious activities	4.35	(0.34)	< 0.001
Listening to music	3.88	(0.075)	< 0.001
Gardening, allotment	4.06	(0.40)	< 0.001
Hunting, fishing	4.80	(1.12)	< 0.001
Pet care, playing with pets	3.56	(0.14)	< 0.001
Childcare, playing with children	3.46	(0.11)	< 0.001
Computer games, iPhone games	3.22	(0.096)	< 0.001
Walking, hiking	2.86	(0.17)	< 0.001
Other games, puzzles	2.65	(0.28)	< 0.001
Watching TV, film	2.40	(0.054)	< 0.001
Match, sporting event	2.80	(0.24)	< 0.001
Eating, snacking	2.41	(0.062)	< 0.001
Cooking, preparing food	2.35	(0.089)	< 0.001
Washing, dressing, grooming	2.16	(0.100)	< 0.001
Listening to speech/podcast	2.09	(0.15)	< 0.001
Gambling, betting	2.47	(0.61)	< 0.001
Reading	1.82	(0.10)	< 0.001
Drinking tea/coffee	1.53	(0.090)	< 0.001
Shopping, errands	1.00	(0.11)	< 0.001
Sleeping, resting, relaxing	1.09	(0.064)	< 0.001
Texting, email, social media	0.77	(0.097)	< 0.001
Browsing the Internet	0.77	(0.094)	< 0.001
Smoking	0.25	(0.15)	0.1082
In a meeting, seminar, class	0.09	(0.11)	0.4311
Housework, chores, DIY	-0.98	(0.085)	< 0.001
Something else (app version < 1.0.2)	-1.30	(0.11)	< 0.001
Admin, finances, organising	-1.79	(0.097)	< 0.001
Working, studying	-1.96	(0.064)	< 0.001
Travelling, commuting	-2.16	(0.099)	< 0.001
Something else (app version \geq 1.0.2)	-3.36	(0.11)	< 0.001
Care or help for adults	-4.39	(0.27)	< 0.001
Waiting, queueing	-4.37	(0.12)	< 0.001
Sick in bed	-20.50	(0.14)	< 0.001

Companionship

Spouse, partner, girl/boyfriend	5.21	(0.051)	< 0.001
<i>continues ...</i>			

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Variable	Coeff.	Std. err.	Pr(coeff. = 0)
Friends	4.64	(0.069)	< 0.001
Other family members	0.76	(0.069)	< 0.001
Clients, customers	0.30	(0.15)	0.0421
Children	0.33	(0.081)	< 0.001
Colleagues, classmates	-0.33	(0.071)	< 0.001
Other people participant knows	-0.99	(0.14)	< 0.001
<i>Time of day, day of week dummies</i>			
Mon – Fri, midnight – < 3am	3.01	(0.42)	< 0.001
Mon – Fri, 3am – < 6am	-0.91	(0.86)	0.2922
Mon – Fri, 6am – < 9am (base category)	—		
Mon – Fri, 9am – < noon	3.39	(0.10)	< 0.001
Mon – Fri, noon – < 3pm	3.77	(0.10)	< 0.001
Mon – Fri, 3pm – < 6pm	3.64	(0.10)	< 0.001
Mon – Fri, 6pm – < 9pm	2.90	(0.10)	< 0.001
Mon – Fri, 9pm – < midnight	3.25	(0.12)	< 0.001
Sat – Sun, midnight – < 3am	4.99	(0.66)	< 0.001
Sat – Sun, 3am – < 6am	1.97	(1.60)	0.2172
Sat – Sun, 6am – < 9am	2.99	(0.20)	< 0.001
Sat – Sun, 9am – < noon	4.48	(0.12)	< 0.001
Sat – Sun, noon – < 3pm	4.53	(0.12)	< 0.001
Sat – Sun, 3pm – < 6pm	4.31	(0.12)	< 0.001
Sat – Sun, 6pm – < 9pm	4.35	(0.12)	< 0.001
Sat – Sun, 9pm – < midnight	4.29	(0.15)	< 0.001
<i>Participant's response number</i>			
Response #1	-6.86	(0.62)	< 0.001
Response #2 – #11	-4.14	(0.065)	< 0.001
Response #12 – #51	-1.13	(0.045)	< 0.001
Response #52+ (base category)	—		
Constant	59.90	(0.14)	< 0.001
Total observations	1138481		
Left-censored observations	10582		
Right-censored observations	80994		
Groups	21947		
Log pseudo-likelihood	-4615852		
Wald χ^2 (df)	177829.58 (91)		< 0.001

Dependent variable: happiness self-report, scaled 0 – 100.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Explanatory variables are listed in the same order as in the main land cover model.

E.6 ESM OLS models

Table E.6 presents two OLS models estimated from our ESM data. The first has the same specification as our main (fixed effects) land cover model, while the second adds participant-level explanatory variables to that specification.

Table E.6: OLS model with response and individual-level variables

Variable	Main land cover specification			Adding participant-level vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
<i>Location</i>						
Indoors (base category)	—			—		
In a vehicle	0.38	(0.25)	0.1237	0.40	(0.25)	0.1080
Outdoors	2.61	(0.60)	< 0.0001	2.56	(0.59)	< 0.0001
<i>Land cover type when participant is outdoors</i>						
Continuous urban (base cat.)	—			—		
Marine and coastal margins	5.34	(0.78)	< 0.0001	5.17	(0.81)	< 0.0001
Mountains, moors and heathland	4.16	(1.02)	< 0.0001	3.93	(0.99)	0.0001
Woodland	2.33	(0.47)	< 0.0001	2.00	(0.47)	< 0.0001
Semi-natural grasslands	2.28	(0.43)	< 0.0001	2.38	(0.45)	< 0.0001
Enclosed farmland	2.82	(0.32)	< 0.0001	2.62	(0.32)	< 0.0001
Freshwater, wetlands and flood plains	1.93	(0.79)	0.0141	1.61	(0.79)	0.0420
Suburban/rural developed	1.19	(0.23)	< 0.0001	1.27	(0.23)	< 0.0001
Inland bare ground	0.26	(0.63)	0.6782	0.35	(0.62)	0.5770
<i>Daylight & weather when participant is outdoors</i>						
Daylight	-0.0062	(0.21)	0.9769	0.017	(0.21)	0.9351
Snow	2.03	(0.90)	0.0243	1.70	(0.91)	0.0614
Sun	0.53	(0.22)	0.0137	0.46	(0.22)	0.0346
Fog	-1.37	(0.65)	0.0348	-1.36	(0.65)	0.0367
Rain	-1.41	(0.26)	< 0.0001	-1.37	(0.26)	< 0.0001
<i>< 0 °C (base category)</i>						
0 – < 8 °C	-0.72	(0.52)	0.1694	-0.87	(0.52)	0.0933
8 – < 16 °C	0.18	(0.56)	0.7450	0.25	(0.56)	0.6469
16 – < 24 °C	1.07	(0.58)	0.0652	1.18	(0.58)	0.0422
24+ °C	5.01	(1.38)	0.0003	4.69	(1.40)	0.0008
<i>0 – < 5 km/h windspeed (base cat.)</i>						
5 – < 15 km/h windspeed	-0.18	(0.25)	0.4694	-0.23	(0.24)	0.3389
15 – < 25 km/h windspeed	-0.48	(0.27)	0.0734	-0.51	(0.27)	0.0567
25+ km/h windspeed	-0.68	(0.33)	0.0402	-0.76	(0.33)	0.0217
<i>Activities</i>						
Intimacy, making love	13.70	(0.38)	< 0.0001	13.70	(0.40)	< 0.0001
Sports, running, exercise	6.96	(0.31)	< 0.0001	6.23	(0.32)	< 0.0001
Theatre, dance, concert	6.58	(0.37)	< 0.0001	6.69	(0.37)	< 0.0001

continues ...

... continued

Variable	Main land cover specification			Adding participant-level vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
Singing, performing	5.52	(1.13)	< 0.0001	5.44	(1.27)	< 0.0001
Exhibition, museum, library	4.77	(0.51)	< 0.0001	4.66	(0.52)	< 0.0001
Hobbies, arts, crafts	5.29	(0.41)	< 0.0001	5.57	(0.42)	< 0.0001
Talking, chatting, socialising	4.82	(0.15)	< 0.0001	4.77	(0.15)	< 0.0001
Birdwatching, nature watching	4.95	(0.85)	< 0.0001	5.02	(0.82)	< 0.0001
Drinking alcohol	4.39	(0.20)	< 0.0001	4.06	(0.19)	< 0.0001
Meditating, religious activities	4.56	(0.62)	< 0.0001	4.64	(0.65)	< 0.0001
Listening to music	3.69	(0.20)	< 0.0001	3.73	(0.21)	< 0.0001
Gardening, allotment	5.94	(0.85)	< 0.0001	5.50	(0.81)	< 0.0001
Hunting, fishing	4.32	(1.80)	0.0163	3.88	(1.90)	0.0412
Pet care, playing with pets	3.01	(0.43)	< 0.0001	3.23	(0.44)	< 0.0001
Childcare, playing with children	3.20	(0.39)	< 0.0001	2.95	(0.37)	< 0.0001
Computer games, iPhone games	2.74	(0.25)	< 0.0001	2.97	(0.25)	< 0.0001
Walking, hiking	2.53	(0.27)	< 0.0001	2.41	(0.27)	< 0.0001
Other games, puzzles	2.21	(0.40)	< 0.0001	2.26	(0.41)	< 0.0001
Watching TV, film	1.95	(0.16)	< 0.0001	2.14	(0.16)	< 0.0001
Match, sporting event	2.56	(0.42)	< 0.0001	2.09	(0.41)	< 0.0001
Eating, snacking	2.10	(0.12)	< 0.0001	2.03	(0.12)	< 0.0001
Cooking, preparing food	2.45	(0.18)	< 0.0001	2.28	(0.18)	< 0.0001
Washing, dressing, grooming	1.69	(0.20)	< 0.0001	1.60	(0.20)	< 0.0001
Listening to speech/podcast	1.62	(0.45)	0.0003	1.36	(0.46)	0.0033
Gambling, betting	2.89	(1.26)	0.0216	2.92	(1.38)	0.0347
Reading	1.36	(0.26)	< 0.0001	1.27	(0.27)	< 0.0001
Drinking tea/coffee	1.66	(0.26)	< 0.0001	1.50	(0.25)	< 0.0001
Shopping, errands	1.04	(0.19)	< 0.0001	0.95	(0.19)	< 0.0001
Sleeping, resting, relaxing	0.76	(0.18)	< 0.0001	0.99	(0.18)	< 0.0001
Texting, email, social media	-0.20	(0.25)	0.4346	-0.31	(0.26)	0.2335
Browsing the Internet	-0.19	(0.24)	0.4134	-0.073	(0.23)	0.7535
Smoking	-0.46	(0.58)	0.4292	1.01	(0.59)	0.0879
In a meeting, seminar, class	0.61	(0.29)	0.0336	0.26	(0.29)	0.3694
Housework, chores, DIY	-0.99	(0.20)	< 0.0001	-1.10	(0.20)	< 0.0001
Something else (app version < 1.0.2)	-2.14	(0.27)	< 0.0001	-1.87	(0.27)	< 0.0001
Admin, finances, organising	-1.91	(0.27)	< 0.0001	-2.05	(0.27)	< 0.0001
Working, studying	-1.94	(0.20)	< 0.0001	-2.17	(0.19)	< 0.0001
Travelling, commuting	-2.35	(0.22)	< 0.0001	-2.65	(0.22)	< 0.0001
Something else (app version ≥ 1.0.2)	-4.65	(0.51)	< 0.0001	-4.57	(0.55)	< 0.0001
Care or help for adults	-3.13	(0.87)	0.0003	-3.06	(0.90)	0.0006
Waiting, queueing	-4.91	(0.25)	< 0.0001	-4.70	(0.25)	< 0.0001
Sick in bed	-21.7	(0.38)	< 0.0001	-20.80	(0.37)	< 0.0001
<i>Companionship</i>						
Spouse, partner, girl/boyfriend	5.87	(0.20)	< 0.0001	5.48	(0.18)	< 0.0001
Friends	4.65	(0.17)	< 0.0001	4.70	(0.16)	< 0.0001
Other family members	1.04	(0.22)	< 0.0001	1.07	(0.21)	< 0.0001
Clients, customers	1.52	(0.52)	0.0035	1.76	(0.52)	0.0008
Children	0.65	(0.34)	0.0553	0.62	(0.33)	0.0586

continues ...

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Variable	Main land cover specification			Adding participant-level vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
Colleagues, classmates	-0.44	(0.22)	0.0435	-0.50	(0.22)	0.0209
Other people participant knows	-1.42	(0.27)	< 0.0001	-1.33	(0.26)	< 0.0001
<i>Time of day, day of week dummies</i>						
Mon – Fri, midnight – < 3am	1.64	(0.91)	0.0731	2.10	(0.84)	0.0125
Mon – Fri, 3am – < 6am	-2.84	(1.66)	0.0871	-2.27	(1.73)	0.1904
Mon – Fri, 6am – < 9am (base cat.)	—			—		
Mon – Fri, 9am – < noon	2.89	(0.19)	< 0.0001	3.17	(0.19)	< 0.0001
Mon – Fri, noon – < 3pm	3.09	(0.20)	< 0.0001	3.46	(0.20)	< 0.0001
Mon – Fri, 3pm – < 6pm	2.98	(0.20)	< 0.0001	3.31	(0.20)	< 0.0001
Mon – Fri, 6pm – < 9pm	2.33	(0.20)	< 0.0001	2.50	(0.20)	< 0.0001
Mon – Fri, 9pm – < midnight	2.46	(0.24)	< 0.0001	2.61	(0.24)	< 0.0001
Sat – Sun, midnight – < 3am	4.08	(1.03)	0.0001	4.94	(0.98)	< 0.0001
Sat – Sun, 3am – < 6am	1.15	(2.02)	0.5691	2.01	(1.93)	0.2982
Sat – Sun, 6am – < 9am	2.95	(0.26)	< 0.0001	2.70	(0.25)	< 0.0001
Sat – Sun, 9am – < noon	3.90	(0.20)	< 0.0001	3.90	(0.20)	< 0.0001
Sat – Sun, noon – < 3pm	3.69	(0.21)	< 0.0001	3.89	(0.21)	< 0.0001
Sat – Sun, 3pm – < 6pm	3.48	(0.21)	< 0.0001	3.67	(0.21)	< 0.0001
Sat – Sun, 6pm – < 9pm	3.40	(0.22)	< 0.0001	3.57	(0.22)	< 0.0001
Sat – Sun, 9pm – < midnight	3.19	(0.26)	< 0.0001	3.32	(0.26)	< 0.0001
<i>Participant's response number</i>						
Response #1	-8.03	(0.74)	< 0.0001	-8.20	(0.76)	< 0.0001
Response #2 – #11	-4.83	(0.19)	< 0.0001	-4.87	(0.19)	< 0.0001
Response #12 – #51	-1.56	(0.17)	< 0.0001	-1.61	(0.17)	< 0.0001
Response #52+ (base cat.)	—			—		
<i>Participant-level variables</i>						
Male				0.21	(0.27)	0.4257
Age				-0.19	(0.11)	0.0712
Age squared				0.0024	(0.0014)	0.0868
Equivalised household income, ln(£)				0.63	(0.19)	0.0011
<i>Health</i>						
Excellent (base category)				—		
Very good				-1.37	(0.42)	0.0012
Good				-4.36	(0.45)	< 0.0001
Fair				-7.32	(0.58)	< 0.0001
Poor				-9.41	(1.50)	< 0.0001
<i>Employment status</i>						
Employed or self-employed (base category)				—		
Retired				1.33	(2.43)	0.5836
Other				0.86	(0.94)	0.3607
In full-time education				-0.33	(0.52)	0.5225
Looking after family or home				-0.65	(1.09)	0.5540

continues ...

... *continued*

Variable	Main land cover specification			Adding participant-level vars.		
	Coeff.	Std. err.	Pr(coeff. = 0)	Coeff.	Std. err.	Pr(coeff. = 0)
Unemployed and seeking work				-2.20	(0.83)	0.0078
Long-term sick or disabled				-5.71	(1.81)	0.0016
<i>Marital status</i>						
Never married (base cat.)						
Divorced				1.37	(0.72)	0.0578
Married and living with spouse				0.80	(0.35)	0.0207
Married but separated				-0.27	(0.95)	0.7792
Widowed				-0.47	(2.99)	0.8739
Constant	61.20	(0.32)	< 0.0001	60.90	(2.62)	< 0.0001
Observations	1138481		1086452			
R ²	11.7%		13.3%			

Dependent variable: happiness self-report, scaled 0 – 100.

Standard errors are clustered at participant level.

Significant coefficients ($p < 0.05$) are marked in **boldface**.

Where applicable, explanatory variables are listed in the same order as in the main fixed effects model.